IN TWO SECTIONS—SECTION ONE

# MECHANICAL ENGINEERING

## INCLUDING THE ENGINEERING INDEX

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

### IN THIS NUMBER



MAY · 1921

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS


# You're looking through Oxygen to read this!

BUT the gas your eye pierces—the gas you inhale at every breath—is but the *raw material* for Linde Oxygen.

Every trace of physical contamination must be eliminated, every chemical impurity removed before atmospheric oxygen is pure enough to meet Linde requirements.

To that end a great army of Linde scientists are constantly at work rigidly maintaining the high standard of Linde purity. To their efforts is due the absolute uniformity for which Linde Oxygen is famous.

A chain of seventy-five plants and warehouses insures prompt deliveries of any volume, anywhere.

THE LINDE AIR PRODUCTS COMPANY

Carbide and Carbon Building, 30 East 42nd Street, New York

Balfour Building, San Francisco

THE LARGEST PRODUCER OF OXYGEN IN THE WORLD

L-503-21

# Mechanical Engineering

The Monthly Journal Published by

## The American Society of Mechanical Engineers

Publication Office, 207 Church Street, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-ninth Street, New York

VOLUME 43 MAY, 1921 NUMBER 5

## TABLE OF CONTENTS



Price 50 Cents a Copy, $4.00 a Year: to Members and Affiliates, 40 Cents a Copy, $3.00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional. Changes of address should be sent to the Society Headquarters.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on January 17, 1921.
C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

# *Contributors and Contributions*

### *Spring Meeting Papers*

Very little fundamental research has been made in the design and use of oxy-acetylene welding and cutting equipment. Consequently the important work along this line by the Bureau of Standards at the request of the War Department and with the coöperation of the Navy will be of great interest. The paper on this subject in this issue is to be presented at the A.S.M.E. Spring Meeting in Chicago by R. S. Johnston, who was the engineer-physicist in charge of the work at the Bureau. A graduate of Tufts in 1908, Mr. Johnston was engaged in structural engineering until 1914, when he joined the instructing staff of the University of Pennsylvania, leaving there to teach at Lafayette. In 1918 he became associated with the Bureau of Standards.

R. S. Johnston

Increases in the size of steam locomotives have brought out design problems not hitherto deemed of unusual importance, and the Spring Meeting Railroad Session will be devoted to their consideration. One of the papers printed in this issue will be presented at that session by M. H. Haig, mechanical engineer for the Santa Fe—a railroad with outstanding experience with large motive-power units.

The testing of moderate-vacuum pumps has been much simplified by the use of low-pressure nozzles as described by Snowden B. Redfield in this issue. Mr. Redfield, a graduate of the University of Pennsylvania, has been in the employ of the Ingersoll-Rand Company for over ten years and is now in charge of its Easton Engineering Department. He was an associate editor of the *American Machinist* in 1909–10. The method of testing outlined by Mr. Redfield is under consideration by the Power Test Codes Committee for inclusion in its revised rules.

J. R. McDermet in his paper in this issue emphasizes the need for more careful boiler-water analyses to reduce corrosion, especially with high steam pressures and rapid rates of evaporation. Mr. McDermet has been research engineer for the Elliott Company since 1915, supervising experimental work and serving as engineer in charge of the Air Separation Division. After being graduated from the University of Illinois in 1912, Mr. McDermet was associated with the University Experiment Station for two years, and later with the Mellon Institute in Pittsburgh.

The tests of the pulverized-coal installation at Milwaukee are a valuable addition to the recorded data on the use of this type of fuel. Henry Kreisinger, the senior author of the paper on this topic, has devoted his entire professional career to the development of economy in the use of fuel, being associated with the U. S. Geological Survey from 1904 to 1910, then with the Clinchfield Fuel Company, and since 1912 with the U. S. Bureau of Mines. Recently he became associated with the Combustion Engineering Corporation. John Blizard, the junior author of the paper, is fuel engineer of the U. S. Bureau of Mines.

### *Engineering Society Organization*

The A.S.M.E. is growing rapidly. To grow in strength, however, close attention must be paid to the Society organization. At the Spring Meeting consideration is to be given to extensive changes in the Constitution and By-Laws, and to shed additional light on the deliberations of the meeting, a paper on the principles of organization of an engineering society will be presented by Morris L. Cooke. Mr. Cooke, well known as a management engineer, is active in a number of engineering societies and has studied the question of society organization carefully. His paper was originally procured for the Spring Meeting Management Session, where the discussion will be held.

### *The Next Issue*

The Spring Meeting will be in session as the June number of Mechanical Engineering comes from the press. It will carry some Spring Meeting papers, however, among them being a notable one by William M. White, of Milwaukee, on the Development of the Hydraucone Regainer, and another by E. G. Bailey, of Cleveland, on Recording Ash-Pit Loss from Chain-Grate Stokers. It will also include the papers to be presented at the Materials Handling Session devoted to Road-Building Machinery.

### *The Editorial Page*

Raymond Walters has made an analysis of the scholastic standing of the eminent engineers of the country, and in an editorial in this issue presents the results of his study in an interesting and instructive way. His figures show a relation between good work done at school and subsequent successful professional work which should be an inspiration to the engineering student.

Intimate contact with lubrication troubles furnished the experience from which C. H. Norton wrote his editorial in this issue. Mr. Norton's exposition of the fallacy involved in the insistence on cool-running bearings should be of interest to every mechanical engineer.

**A.S.M.E. SPRING MEETING**


*For details see pages 352–353*

MECHANICAL ENGINEERING

Volume 43 May, 1921 Number 5

# An Investigation of Oxy-Acetylene Welding and Cutting Blowpipes

By R. S. JOHNSTON,[1] WASHINGTON, D. C.

*This paper reports the results of and conclusions from an elaborate series of tests carried out by the Bureau of Standards, Washington, D. C., for the War Department on commercial apparatus for cutting and welding by the oxy-acetylene process, submitted by manufacturers for the purpose of the tests.*

*The welding tests were performed upon 1/2-in. and 3/4-in. steel plates and the cutting tests upon 1/2-in., 2-in., 6-in. and 10-in. material.*

*The general conclusions from the tests were that there was a great deal of difference between the characteristics of different designs of cutting blowpipes, and that there was no make of apparatus which was equally proficient and economical for all the thicknesses of metal. Further, one of the prime essentials of a good welding blowpipe is its so-called gas ratio, which should be unity. Not any of the blowpipes tested proved capable of maintaining a gas ratio of unity during welding, although, as the author states, the welds were probably made with greater care than has ever been bestowed upon any like work.*

*The important problem of "flashback" receives extensive consideration, and the author concludes that a blowpipe designed to be absolutely free from flashback caused by any form of obstruction, under all working conditions, will also be the eminently safe blowpipe and the one which with ordinary care will produce sound welds. Such a blowpipe will be one so designed that, under all conditions of operation even to complete blocking of the gas exit at the tip end, there will be maintained a one-to-one volume delivery of each gas, at identical pressures.*

*In addition to the particulars regarding welding tests here presented, the complete paper gives full details of the series of cutting tests.*

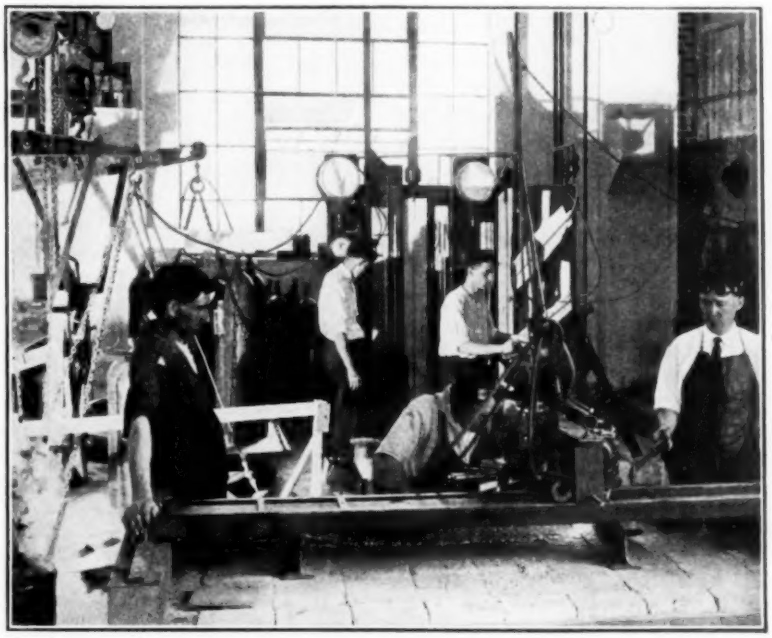


Fig. 1 Entire Testing Equipment

IN THE WAR the increased use by the American Expeditionary Forces of oxy-acetylene welding and cutting equipment necessitated large purchases by the Government. In discussions concerning the relative merits of procurable apparatus it became evident that no authentic data were available as to the relative merits of the various blowpipes. The Bureau of Standards was therefore requested by the Chief of Ordnance to make a test for the determination of "efficiency, safety and workmanship entering into the several makes of apparatus" (oxy-acetylene).

Of necessity, the emergency of the investigation limited its proposed scope. The manufacturers of welding and cutting blowpipes were invited to conference and were circularized in regard to methods of test. From a study of the results of these conferences and correspondence a tentative scheme of tests was developed. A series of preliminary tests was started, and from the results a set of tests and a method of conducting them were decided upon. Further study made it desirable that a more extended investigation of the oxy-acetylene blowpipe be made. The signing of the armistice relieved the urgency and a much more complete series of tests was proposed. The results of these tests are included in this paper.

In deciding on the final tests S. W. Miller, Mem.Am.Soc.M.E., was engaged as consulting engineer. After securing his suggestions the tests were submitted to the War Department for final suggestions before being submitted to the manufacturers of the apparatus to be tested.

Several weeks of preliminary work were given over to acquainting the expert welders and cutters from the Naval Gun Factory, Washington, D.C., and the New York Navy Yard with their new duties. The knowledge that the tests were to be started, together with the fact that most of the apparatus had been held for test for at least a year, brought forth requests from the manufacturers for the privilege of submitting new and improved apparatus, which were granted.

A copy of the tests to which it was proposed to submit blowpipes, accompanied by a circular letter giving the sizes and chemical analyses of the materials to be cut and welded, was forwarded to each manufacturer for him to furnish certain information. Each concern was later also individually notified of the day upon which its apparatus was scheduled to be tested.

The tests occupied about three months.

Acknowledgment

In the development of this investigation the general experience of a number of people was drawn upon that the question might be viewed from its broadest aspects, and its successful completion was largely due to the splendid coöperation received. Appreciation for such assistance is expressed to Col. L. B. Moody, Ordnance, War Department; Lt. Col. Warren R. Roberts, Q. M. C., War Department; Maj. A. B. Quinton, Jr., Ordnance, War Department; Maj. R. F. Carr, U. S. A., War Department; Maj. W. L. Simpson, Ordnance, War Department; Capt. A. L. Willard, Naval Gun Factory, Washington, D.C.; Capt. C. H. Rock, Hull Division, New York Navy Yard; and to the officers of the divisions of the

[1] Engineer-Physicist, U. S. Bureau of Standards, Washington, D. C.

Abstract of a paper to be presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be had on application. All papers are subject to revision.

Published by permission of Dr. S. W. Stratton, Director Bureau of Standards.

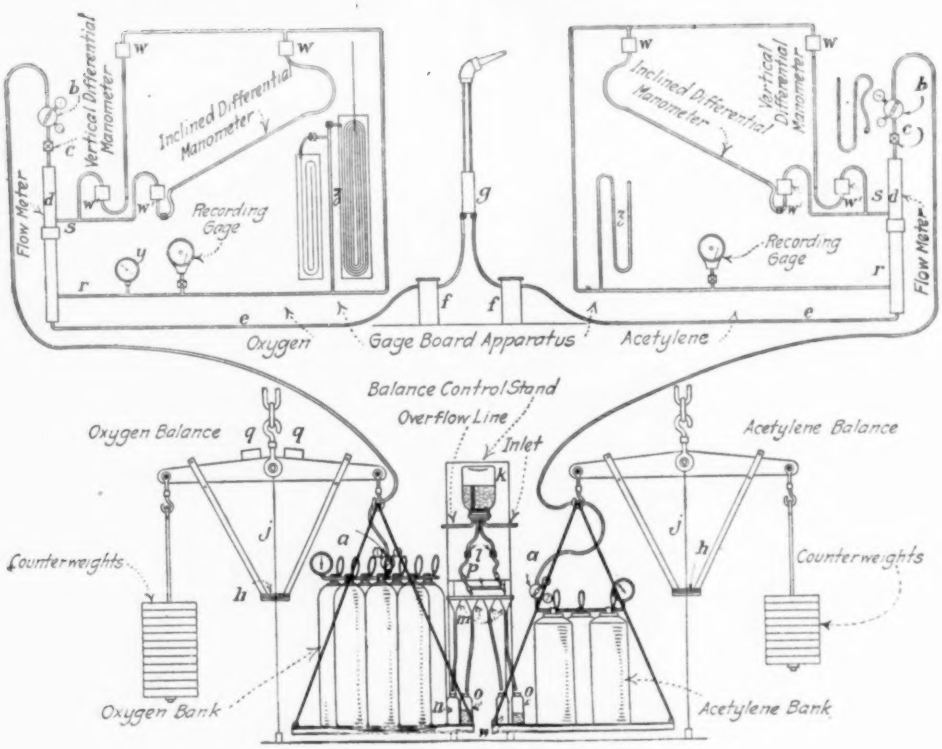



Fig. 2 Diagram of Entire Testing Equipment

Bureau of Standards and the several manufacturers of oxy-acetylene equipment.

The paper presented herewith is the result of a special investigation conducted at the Bureau of Standards for the War Department as represented by Major A. B. Quinton, Jr., Tank, Tractor and Trailer Division, Ordnance Department, through which Department the results of the investigation have been made available for public distribution.

## Summary of Results

The results of this investigation would seem to warrant the following statements:

*For the Cutting Blowpipes:*

*a* That there is today no generally accepted theory for proportioning, for the cutting of metal of various thicknesses, the volume and velocity of the issuing cutting jet, with the result that none of the apparatus submitted to test proved economical for all thicknesses.

*b* That there is for any thickness of metal cut a limiting velocity of exit of the cutting jet at which complete utilization of the oxygen takes place, and a limiting value for the amount of oxygen required to produce a cut.

*c* That an increase in acetylene consumption, or oxygen consumption, or of the velocity of exit of the cutting jet beyond the limiting values, does not produce increased efficiency in commensurate ratio.

*d* That a large majority of the blowpipes tested were equipped with excessive preheating flames for the thickness of metal the tip is specified for, and that such excessive-sized flames are disadvantageous both from the standpoint of economy of operation and quality of work performed.

*e* That considerable improvement in economy of operation seems possible in cutting material of 2 in. thickness and that possibly this condition may be found to exist for metal of other thicknesses than those used in the tests.

*f* That the maximum thickness of metal that may be economically cut with an oxy-acetylene blowpipe of standard design when neither the material nor the oxygen is preheated and the cutting is done only from one direction, is about 12 in.

*g* That the cutting blowpipes due to their incorrect design are subject to the same "flashback" troubles found in the welding blowpipes.

*For the Welding Blowpipes:*

*a* That the blowpipes most subject to the so-called phenomena of flashback are those in which the oxygen is delivered at a pressure in excess of that at which the acetylene is delivered.

*b* That all the blowpipes tested, including those in which the acetylene is delivered at an excess pressure as well as the so-called equal- or balance-pressure blowpipes, are subject to flashback phenomena on account of inherent defects in their design.

*c* That the cause of the development of the conditions producing flashback is the setting up within the blowpipe tip and head of a back pressure which retards or chokes off the flow of one of the gases.

*d* That this back pressure is the result of confining or restricting the volume flow of the issuing gases at the tip end.

*e* That any cause tending to restrict the flow of the gases sets up a back pressure which immediately causes a change in the amount of each gas delivered to the mixing chamber.

*f* That a fluctuating gas-volume ratio, due to the restriction of volume flow, from whatever cause, prevents a blowpipe from maintaining constantly and at all times during operation the desired "neutral flame."

*g* That a blowpipe that cannot maintain under all operating conditions a neutral flame cannot logically be expected to produce sound welds.

*h* That all the blowpipes tested during this investigation either through improper gas pressures or improper interior design or both are incapable of maintaining a neutral flame (constant-volume gas ratio) under all conditions of restricted gas flow and are therefore incapable of producing sound welds where there is any liability of the gaseous products of combustion being momentarily confined such as occurs in practically all welding operations.

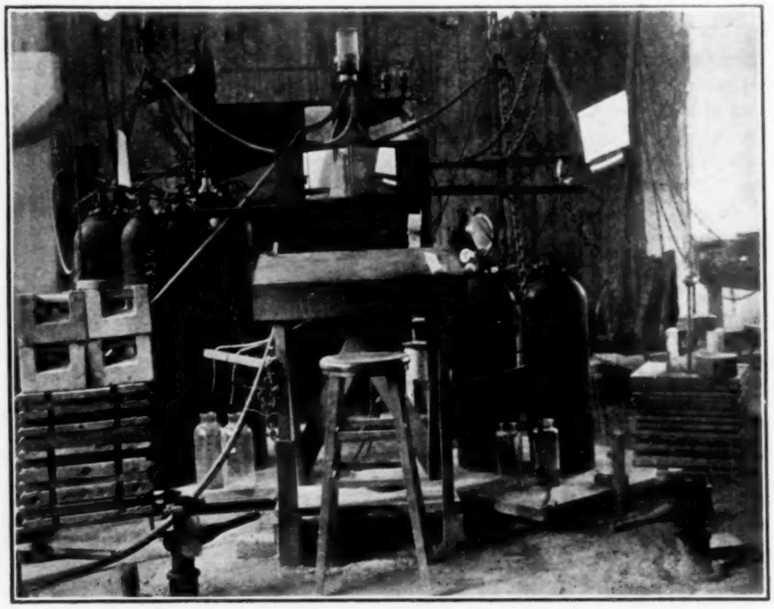


Fig. 3 Operator's Table and Balances

*i* That the ability of a blowpipe to consume an equal volume ratio of gases when burning freely and undisturbed in air is no criterion that it is capable of producing sound welds, i.e., that it is

not subject to detrimental fluctuations in gas ratio during a welding operation and therefore is capable of maintaining a neutral flame under all operating conditions.

*j* That whether a blowpipe of present designs will consume an equal volume ratio of gases when burning freely and undisturbed in air depends on how nearly correct the operator sets the so-called "neutral flame," and experience indicates that the average operator checks the acetylene gas flow too much and actually develops an oxidizing rather than a neutral flame.

*k* That the question of the possible limiting strength and ductility or the efficiency of welds made by the oxy-acetylene welding blowpipe must await the development of a more satisfactory instrument, and that having such an instrument there is no reason to believe that a weld of clean, sound metal cannot be made with assurance during any welding operation and that such welds will or can be made to possess the proper physical properties.

## Description of Equipment Used

In general the equipment used for making the tests may be listed as:

*a* Weighing system for determining amount of gases used during tests by loss of tank weight

*b* Gage-board system containing necessary pressure gages, regulators and orifice flowmeters

*c* Welding table

*d* Cutting table

*e* Flashback and safety testing apparatus.

Figs. 1 and 2 show the entire equipment. The tanked gases are "banked" and counterpoised on an equal-arm balance. The gas from these tanks passes through a regulator *a*, thence through a flexible hose to the back of the gage board. Passing through the board the supply line enters a second regulator *b*, thence through a needle valve *c*, to the top of and through an orifice flowmeter *d*. The gas coming from the extreme bottom of the flowmeter is then conducted through a standardized length of flexible hose *e*, containing a safety flashback tank *f*, to the blowpipe to be tested.

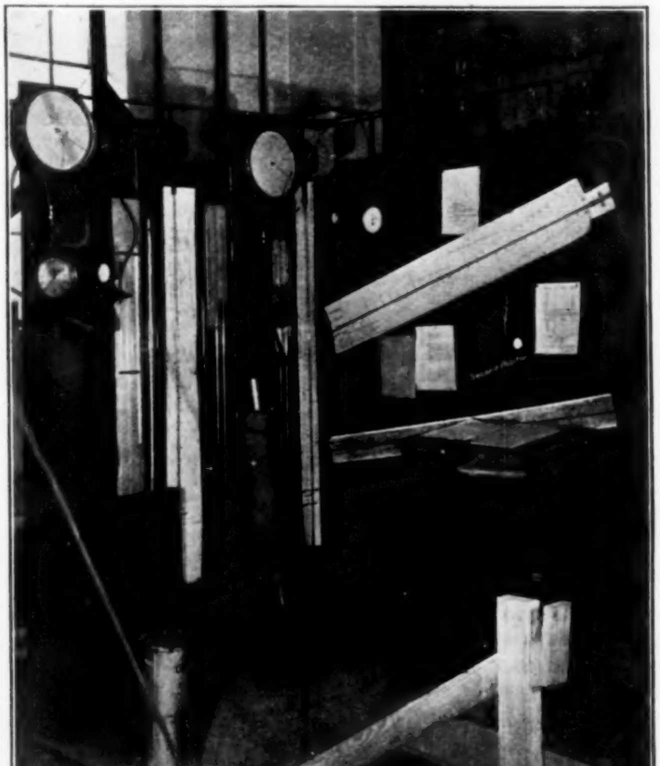


Fig. 4 Gage-Board System

Fig. 3 is a view of the operator's table, showing the use of mirrors for taking practically simultaneous readings of the balances.

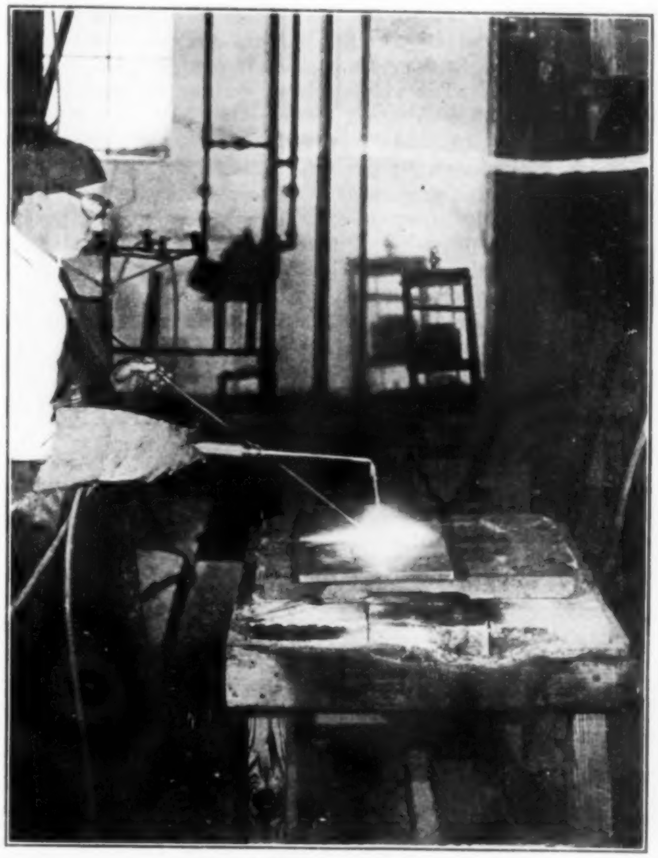


Fig. 5 Welding Table

Fig. 4 shows the gage-board system. In the center of the board is one of the flowmeters, surrounded by wool-felt insulation.

## Accuracy of Tests

Unusual precautions were taken to insure accuracy. If the gas losses through leakage exceeded 0.01 to 0.02 lb. per hour, actual testing of the blowpipes was not continued until the leaks causing such losses were located and stopped.

The values obtained for gas consumption were accurate to 0.005 lb., and in most cases probably much closer.

With the precautions taken with the regulators, it was readily possible to maintain under almost all conditions a pressure varying not more than 0.01 or 0.02 lb. from the desired amount. Autographic records gave visual evidence of the absolute uniformity of the pressure under which the blowpipes were operated during the tests.

Special orifice flowmeters were designed to facilitate securing data on continuous blowpipe action and as a check on the weighing system.

To complete the records the gage board was equipped with a standard calibrated thermometer, a psychrometer, a barometer and a stop watch.

Elaborate precautions were taken to maintain the gas conditions constant during the tests.

## The Welding Table

All welding during the tests was performed upon the welding table illustrated in Fig. 5. This was a wooden-frame table approximately three feet square, the top of which was composed of firebricks. On top of the firebricks was placed a heavy casting channeled for a width of about six inches throughout its length. This formed the base upon which all the plates for welding rested during the welding operation. The plates were aligned centrally along this base with the idea that the casting with its grooved surface would permit of better heat radiation along the line of the weld and at the same time form a baseplate or background to prevent possible inconveniences from the blowholes caused by blowing the welded material through the bottom of the V of the test weld plates.

As indicated in Fig. 5, the line of the weld was placed directly in front of the welder and the welding was performed from the back toward the operator, thus giving him a full view of the work as it progressed. The welded plates were cut so that the welds were 1 ft. in length. Where 2 ft. of weld were made continuously, pairs of plates were set in front of each other with a slight space between the individual pairs and with proper allowance for expansion so that the process could be carried from one plate to the other without any interruption. The groove along the baseplate facilitated the preheating of the second pair of plates, so that the start upon the second weld was made under practically the identical conditions which existed when the first pair of plates was finished, a condition that would be equivalent to that which would occur if the weld was made as one of 2 ft. length instead of two of 1 ft.

### The Flashback and Safety Apparatus

*Flashback-Protection Tanks.* The testing equipment also included in the gas lines two flashback tanks (*f*, Fig. 2, and Fig. 1). These tanks were essentially hydraulically controlled valves which

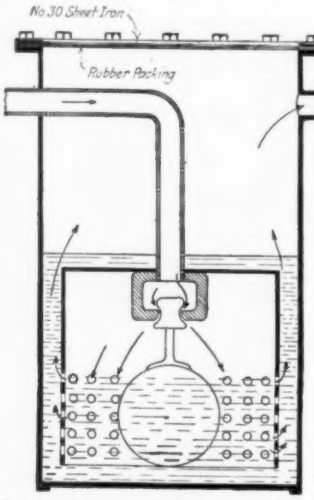



Fig. 6 Flashback-Protection Tank

were intended to prevent the propagation of an explosion in the blowpipe or gas line backward toward the gas supply. They are shown in sectional view in Fig. 6. While it was generally realized that the installation of the water seal of these flashback-protection tanks might be considered detrimental, due to the absorption of moisture by the gas, it became evident that their installation was nevertheless a prime necessity as a means of protecting the rather expensive gage-board equipment. It was believed further that, inasmuch as the oxygen in use generally came from cylinders that contained more or less water, the passing of the gas through the hydraulic seal of the flashback-protection tank would in reality tend to standardize the moisture content in the gas and therefore produce similar effects for all blowpipes.

These flashback-protection tanks proved extremely satisfactory for the purpose intended in that in several explosions they prevented the propagation of the flame beyond the flash tank. They generally ruptured by the blowing off of the head of the tank during the explosion. As furnished the heads were of rather thick sheet metal, fastened on with bolts as indicated on Fig. 6. This construction proved to be somewhat dangerous to the operators making the tests and the tanks were therefore modified in their construction as indicated in the figure by having a rubber packing and a thin sheet of metal fastened to the top with a heavy annulus. By this construction it was expected that if an explosion developed within the flash tank the thin metal sheet would rupture by tearing and thus minimize danger from flying parts.

### Materials Used in Tests

*Welding Rod.* The welding rod used throughout the entire series of tests was secured from the Naval Gun Factory, Navy Yard, Washington, D. C. This rod was purchased in July 1917 under Navy Department Specification 22-W-4. A number of chemical analyses were made and the percentage composition was found to be as follows:

| | | | |
|---|---|---|---|
| Carbon | 0.024 to 0.03 | Silicon | 0.002 to 0.004 |
| Manganese | 0.05 to 0.08 | Chromium | Trace |
| Phosphorus | 0.01 to 0.015 | Nickel | Not detected qualitatively |
| Sulphur | 0.023 to 0.024 | Vanadium | Not detected qualitatively |

*Steel Plates for Welding and Cutting.* The steel plates used for welding were $^1/_2$ in. and $^3/_4$ in. in thickness. The material used for cutting was $^1/_2$, 2, 6 and 10 in. in thickness. All the material used in both welding and cutting except the 10-in. was furnished through the Engineer Corps, War Department, and was selected with special reference to uniform quality for any particular thickness. The $^1/_2$-in. material was furnished in plates 3 ft. by 5 ft. in size and was used for both welding and cutting tests. The middle section of each plate was retained as a sample for determining the qualities of the plate. The remaining pieces were used for making welds. During the welding tests it was the practice to use plates that were adjacent to each other in the main or full plate before it was cut into weld specimens, so that as nearly as possible the material used for any particular test would be identical.

The $^3/_4$-in. material for welds was received in plates 12 in. wide by 6 ft. in length. These plates were cut up into sections 9 in. in length, and for the full width of the plate, that is 12 in. All specimens for welding tests were finished with a butt joint of the single V 90-deg. included-angle type.

For the cutting tests the 3-ft. by 5-ft. by $^1/_2$-in. plates were cut into strips approximately $1^1/_2$ to 2 in. in width. The 2-in. material for cutting was furnished in sections 2 in. by 6 in. by 20 ft. These were cut, for convenience in handling, into 5-ft. lengths and in test operations cut lengthwise into sections 2 in. in width. The 6-in. material was shell billet steel furnished in 3-ft. lengths and was cut lengthwise in test operations.

Chemical analyses of a part of these materials indicated that they were of approximately the following percentage compositions:

| *$^1/_2$-in. Mild-Steel Plate for Welding and Cutting Tests:* | | *$^3/_4$-in. Plate for Welding Tests:* | |
|---|---|---|---|
| Carbon | 0.14 | Carbon | 0.25 to 0.27 |
| Manganese | 0.32 to 0.36 | Manganese | 0.41 to 0.48 |
| Phosphorus | 0.012 to 0.013 | Phosphorus | 0.011 to 0.013 |
| Sulphur | 0.033 to 0.055 | Sulphur | 0.041 |
| Silicon | 0.006 to 0.012 | Silicon | 0.004 |

### Description of the Tests

The tests were started with the idea of submitting each manufacturer's equipment to the series of tests listed in a circular sent out under date of February 18, 1920. It was found, however, that the proposed series of tests was excessive from the time standpoint. One of the most serious drawbacks as a time-consuming element was the fact that a very large percentage of the blowpipes submitted for test would not operate with the pressures specified by the manufacturers. This condition was probably due to the fact that it is quite a customary practice to recommend setting the regulator pressures three to five pounds higher than the specified blowpipe pressures. By throttling the gases at the blowpipe-handle valves the operator insures having sufficient pressure available at all times to maintain the required velocity of exit of the gases at the tip end. He is therefore enabled to compensate for pressure fluctuations due to irregular action of the regulator, thus tending to minimize the development of flashbacks. The specifications for the tests distinctly stated that at least one of the blowpipe-handle valves must be maintained at full opening during a test. It was only by such a procedure that the gas consumption of a blowpipe could be definitely ascertained. For a great many of the blowpipes the pressures were too high to enable the maintenance of a stable flame with one of the handle valves at full opening.

Another quite serious source of trouble from the standpoint of time consumption was that due to leakage necessitating the dismantling and repacking of valves.

In order, therefore, that the entire investigation might not require an undue length of time it was decided that attention should be devoted only to the so-called primary tests, consisting of the welding, cutting, gas-ratio, and flashback tests. Such proposed tests as the variation of pressure within the blowpipe head, etc.,

TABLE 1 SUMMARY OF TESTS FOR GAS RATIOS
Bureau of Standards Investigation

| Torch No. (1)[1] | Test Number 1a (2) | 1b (3) | 2 (4) | 5a1 (5) | 5b (6) | With gratings 5a1 (7) | With gratings 5b (8) |
|---|---|---|---|---|---|---|---|
| 1 | 1.13 | 1.16 | 1.14 | 1.19 | 1.08 | 1.04 | 1.01 |
| | (1.11)[2] | (1.15) | (1.14) | (1.18) | (1.04) | (1.05) | (0.981) |
| 2 | 1.12 | 1.07 | 1.08 | 1.04 | 1.06 | 1.04 | 0.992 |
| | (1.11) | (1.06) | (1.06) | (1.04) | (1.04) | (1.02) | (0.996) |
| 3 | 1.21 | 1.26 | 1.13 | 1.10 | 1.07 | 1.01 | 1.04 |
| | (1.18) | (1.23) | (1.19) | (1.07) | (1.09) | (1.01) | (1.09) |
| 4 | 1.13 | 1.09 | 1.41 | 1.14 | 1.29 | ... | ... |
| | (1.13) | (1.09) | (1.16) | (1.15) | (1.10) | ... | ... |
| 5 | 1.07 | 1.05 | 1.03 | 1.02 | 1.04 | 1.01 | 0.999 |
| | (1.05) | (1.04) | (1.13) | (1.02) | (1.10) | (1.01) | (1.03) |
| 6 | 1.10 | 1.11 | 1.14 | 1.12 | 1.17 | 1.06 | 1.08 |
| | (1.10) | (1.11) | (1.15) | (1.12) | (1.16) | (1.03) | (1.07) |
| 7 | 1.07 | 1.05 | 1.03 | 1.04 | 1.07 | 1.05 | 1.02 |
| | (1.04) | (1.03) | (1.02) | (1.01) | (1.03) | (1.01) | (0.994) |
| 8 | 1.13 | 1.12 | 1.18 | 1.27 | 1.43 | 1.05 | 1.01 |
| | (1.12) | (1.12) | (1.16) | (1.28) | (1.38) | (1.03) | (0.986) |
| 9 | 1.15 | 1.18 | 1.19 | 1.14 | 1.14 | 1.43 | 1.19 |
| | (1.18) | (1.24) | (1.17) | (1.14) | (1.15) | (1.39) | (1.15) |
| 10 | 1.12 | 1.15 | 1.19 | 1.10 | 1.04 | 1.03 | 1.01 |
| | (1.11) | (1.13) | (1.06) | (1.09) | (1.05) | (0.989) | (0.992) |
| 11 | 1.19 | 1.20 | 1.26 | 1.27 | 1.09 | 1.21 | 1.04 |
| | (1.19) | (1.21) | (1.23) | (1.28) | (1.08) | (1.19) | (1.05) |
| 12 | 1.21 | 1.21 | 1.13 | 1.02 | 1.04 | 1.02 | 1.02 |
| | (1.17) | (1.20) | (1.11) | (1.01) | (1.02) | (0.998) | (0.979) |
| 13 | 1.02 | 1.13 | 1.09 | 1.09 | 1.07 | 1.02 | 1.00 |
| | (1.04) | (1.12) | (1.09) | (1.08) | (1.06) | (1.01) | (1.00) |
| 14 | 1.07 | 1.09 | 1.08 | 1.08 | 1.10 | 0.999 | 0.956 |
| | (1.06) | (1.08) | (1.07) | (1.08) | (1.10) | (0.992) | (0.964) |

[1] Numbers (1) to (8) are column numbers.
[2] Values in parentheses are computed from flowmeter data.

were therefore abandoned. On the basis of the foregoing the following schedule of tests was adopted and all blowpipes tested during this investigation were submitted to them.

*Welding Tests.* All blowpipes reported upon were submitted to five welding tests, designated respectively as Tests 1*a*, 1*b*, 1*c*, 1*d*, and 2. All the tests numbered 1 were made with 1/2-in. plate. Test 2 was a weld with 3/4-in. plate.

Tests 1*a* and 1*b* were made with the tip sizes and pressures specified by the manufacturer when this was possible. For both of these tests a 2-ft. length of weld was made. These tests were identical in all respects with the exception that an attempt was made to evaluate the personal equation by using different operators. For Tests 1*c* and 1*d* a 12-in. length of weld was made. Both of these welds were made by the operator who made the weld of Test 1*a*, the idea being to maintain as nearly constant a personal equation for this series of tests as possible. Test 1*c* was run with the same size tip as 1*a*, but with pressures (both oxygen and acetylene) 50 per cent in excess of the pressures used for Test 1*a*. Test 1*d* was carried out similarly to 1*c* except that the pressures were 25 per cent below those used in Test 1*a*.

As mentioned above, the pressures specified by the manufacturer very often gave an exit velocity to the gas too high to permit of maintaining a stable flame at the blowpipe tip. In such cases the manufacturer's representative was requested to furnish a modified pressure that would enable the maintenance of a stable welding flame. Very often the modified pressure thus determined upon would not permit of the application of Test 1*c*, that is, a test with a 50 per cent increase in pressure in both gas lines. It was customary, therefore, in such cases to modify the test procedure and incorporate as a test in place of Test 1*c*, Test 1*e*, which was run under identical conditions with the above test with the exception that the pressure on both gas lines was reduced to 50 per cent of the pressure used to make Test 1*a*.

Tests 1*c*, 1*d*, and 1*e* were incorporated to show the effects of increased or decreased pressures on the operation and economy of the blowpipe. Such excess or decreased pressures are found to be quite common in many welding operations, due to carelessness on the part of the operator in setting regulator pressures or to imperfect regulator action. It was felt that a properly designed blowpipe should be capable of adjustment over a considerable range for any specified tip size. It was hoped in the investigation to secure data that would either verify this assumption or prove that it was absolutely essential to maintain exact pressures for satisfactory blowpipe operation.

Test 2 was a 12-in. length of weld of 3/4-in. mild-steel plate. This weld was made in all cases by the operator who made the weld of Test 1*b*. This test was selected as indicating the probable results to be obtained with a blowpipe in heavy welding, and with Test 1 it was felt that it would give a fair idea of the adaptability of the blowpipe for welding purposes. The tips for welding 1/2-in. and 3/4-in. plate were selected as being the tips used respectively for the average-size weld and for the maximum-size weld, and therefore the best general average for determining the blowpipe's efficiency and safety.

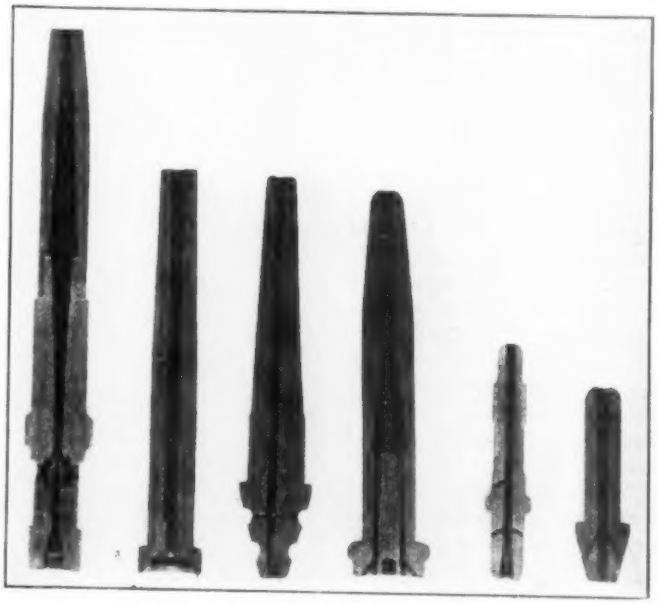


Fig. 7 Cross-Sections of Blowpipe Tips

TABLE 2 SUMMARY OF RESULTS OF TENSILE AND BEND TESTS OF OXY-ACETYLENE WELDS
Bureau of Standards Investigation, Tests 1*a*, 1*b*, 1*c*, 1*d*, 2
(Weld made in Tests 1*a*, 1*b*, 1*c*, 1*d*, 2)

| Torch No. (1)[3] | Test Number 1a Ult. T. S.[1] (2) | 1a Incl. angle[2] (3) | 1b Ult. T. S. (4) | 1b Incl. angle (5) | 1c Ult. T. S. (6) | 1c Incl. angle (7) | 1d Ult. T. S. (8) | 1d Incl. angle (9) | 2 Ult. T. S. (10) | 2 Incl. angle (11) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 39.3 | 116 | 44.4 | 115 | 33.1 | 44 | 42.1 | 77 | 43.6 | 51 |
| | 44.9 | 121 | 47.4 | 95 | ... | ... | ... | ... | ... | ... |
| 2 | 41.2 | 29 | 39.4 | 39 | 41.2 | 67 | 45.8 | 58 | 43.7 | 69 |
| | 44.1 | 56 | 43.9 | 67 | ... | ... | ... | ... | ... | ... |
| 3 | 31.9 | 50 | 27.9 | 28 | 43.0[4] | 94[4] | 35.3 | 37 | 33.2 | 30 |
| | 32.1 | 36 | 35.9 | 20 | 38.9[5] | 62[5] | ... | ... | ... | ... |
| 4 | 36.2 | 62 | 41.4 | 95 | 40.6 | 61 | 39.0 | 107 | 53.5 | 117 |
| | 43.0 | 41 | 36.7 | 73 | ... | ... | ... | ... | ... | ... |
| 5 | 43.0 | 72 | 31.1 | 63 | 43.6 | 34 | 32.1 | 18 | 33.0 | 52 |
| | 46.3 | 25 | 37.7 | 63 | 42.9[5] | 42[5] | ... | ... | ... | ... |
| 6 | 40.6 | 72 | 45.8 | 59 | 34.4 | 16 | 44.3 | 56 | 48.6 | 44 |
| | 43.7 | 69 | 42.3 | 65 | ... | ... | ... | ... | ... | ... |
| 7 | 44.2 | 33 | 37.3 | 56 | 36.1 | 73 | 36.3 | 53 | 48.2 | 49 |
| | 46.0 | 77 | 40.8 | 65 | ... | ... | ... | ... | ... | ... |
| 8 | 43.4 | 43 | 39.8 | 64 | 32.9 | 20 | 39.5 | 80 | 41.4 | 74 |
| | 43.8 | 70 | 42.6 | 60 | ... | ... | ... | ... | ... | ... |
| 9 | ... | .. | 34.9 | 38 | 42.0 | 67 | 44.1 | 71 | 44.9 | 57 |
| | 46.5 | 62 | 45.2 | 39 | ... | ... | ... | ... | ... | ... |
| 10 | 41.9 | 54 | 35.1 | 26 | 47.7[4] | 89[4] | 45.6 | 72 | 39.4 | 23 |
| | 43.1 | 59 | 39.6 | 51 | ... | ... | ... | ... | ... | ... |
| 11 | 43.8 | 54 | 38.7 | 66 | 37.9 | 36 | 38.4 | 96 | 45.1 | 39 |
| | 27.0 | 51 | 29.2 | 57 | 32.8 | 38 | ... | ... | ... | ... |
| 12 | 40.4 | 43 | 39.0 | 54 | 42.3 | 60 | 49.4 | 94 | 45.8 | 62 |
| | 40.2 | 32 | 39.5 | 56 | ... | ... | ... | ... | ... | ... |
| 13 | 39.3 | 51 | 31.0 | 83 | 40.1 | 61 | 34.4 | 82 | 48.3 | 58 |
| | 52.1 | 61 | 41.6 | 24 | ... | ... | ... | ... | ... | ... |
| 14 | 40.4 | 63 | 45.6 | 107 | 39.4 | 52 | 42.4 | 65 | 38.1 | 38 |
| | 41.0 | 49 | 46.5 | 66 | ... | ... | ... | ... | ... | ... |
| Average: | | | | | | | | | | |
| 1st plate | 40.4 | 57 | 38.0 | 64 | 38.6 | 49 | 40.6 | 69 | 43.3 | 54 |
| 2nd plate | 42.4 | 58 | 40.6 | 57 | 32.8 | 38 | ... | ... | ... | ... |
| General Average[6] | 41.4 | 57 | 39.3 | 60 | 35.7 | 44 | 40.6 | 69 | 43.3 | 54 |

Average ultimate tensile strength of all welded 1/2-in. plates .......... 39.2 lb. per sq. in.
Average ultimate tensile strength of unwelded 1/2-in. plate .......... 54.9 lb. per sq. in.
Efficiency of welds in 1/2-in. plate .......... 71.4 per cent
Tests 1*a* to 1*d*, inclusive, were welds made with 1/2-in. plates; Test 2 with 3/4-in. plate.

[1] Ultimate tensile strength in thousands of pounds per square inch.
[2] Included angle of bend, cold-bend test. Bottom of V in compression. Pin diameter equal to thickness of metal. Included angle for unwelded plate = 180 deg.
[3] Numbers in parentheses are column numbers.
[4] Weld made at — 50 per cent pressure instead of at +50 per cent pressure.
[5] Weld made at normal pressure instead of at + 50 per cent pressure.
[6] Welds referred to in [5] and [6] are not included in the general average.

*Gas-Ratio Tests.* One of the prime essentials of a good welding blowpipe is its so-called gas ratio, that is, the ratio of the volume of oxygen to the volume of acetylene consumed. Theoretically a properly adjusted blowpipe requires equal volumes of both gases, giving the ratio of 1 : 1. In order to establish the ratios of the blowpipes under test each one reported upon was submitted to a series of gas-ratio tests, numbered 5*a*1 and 5*b*.

For these tests the blowpipe was allowed to burn freely in air with the same tip sizes and pressures as were used in the welding tests mentioned above. The blowpipe was supported upon a bracket stand with the tip in horizontal position. All gas-ratio tests were made upon the tips used for welding and no attempt was made to clean them before making the tests other than to blow them out with a rather high oxygen pressure. These tests might be expected to indicate the gas consumption of the blowpipe with the flame burning undisturbed from accidental obstructions, such as slag adhesions to the ends of the tips, etc., which occur in actual welding practice. The discussion of the welding blowpipe furnishes additional interesting information concerning the gas-ratio tests.

*Flashback Tests.* In order to determine the probable safety of operation of a welding blowpipe and, further, to secure information concerning the permanency of construction of the tip and blowpipe head, the blowpipes reported upon were submitted to two types of flashback tests.

One series of tests designated 3*a* and 3*b*, flashback tests on the tips used for welding 1/2-in. metal and 3/4-in. metal, respectively, consisted of the standard series of tests used by the Underwriters' Laboratories for determining the freedom from flashback and the safety of the welding blowpipe. Each of these tests consisted of four distinct operations. The first three of these operations were carried out as follows: After being properly adjusted to neutral flame the blowpipe was tested for flashback by drawing the tip at varying angles across the surface of, and finally pressing the tip end firmly against, certain materials. For this test a cold steel plate, a firebrick, and a piece of wood were used. Finally the tip was used to make a pool of molten metal in a cast-iron block, flux being used to assist in maintaining the fluid condition of the metal, and the tip suddenly plunged into the pool of metal.

Another series of tests intended to determine the permanency of construction and designated as the Severe Flashback Test, Test 4, was carried out by supporting the blowpipe on a vertical sliding carriage in such a manner that at the proper instant the ignited and carefully adjusted blowpipe could be lowered so that the end of the tip was directly over the center of a hole 2 in. in diameter and 2 in. deep, drilled in a heavy cast-iron block.

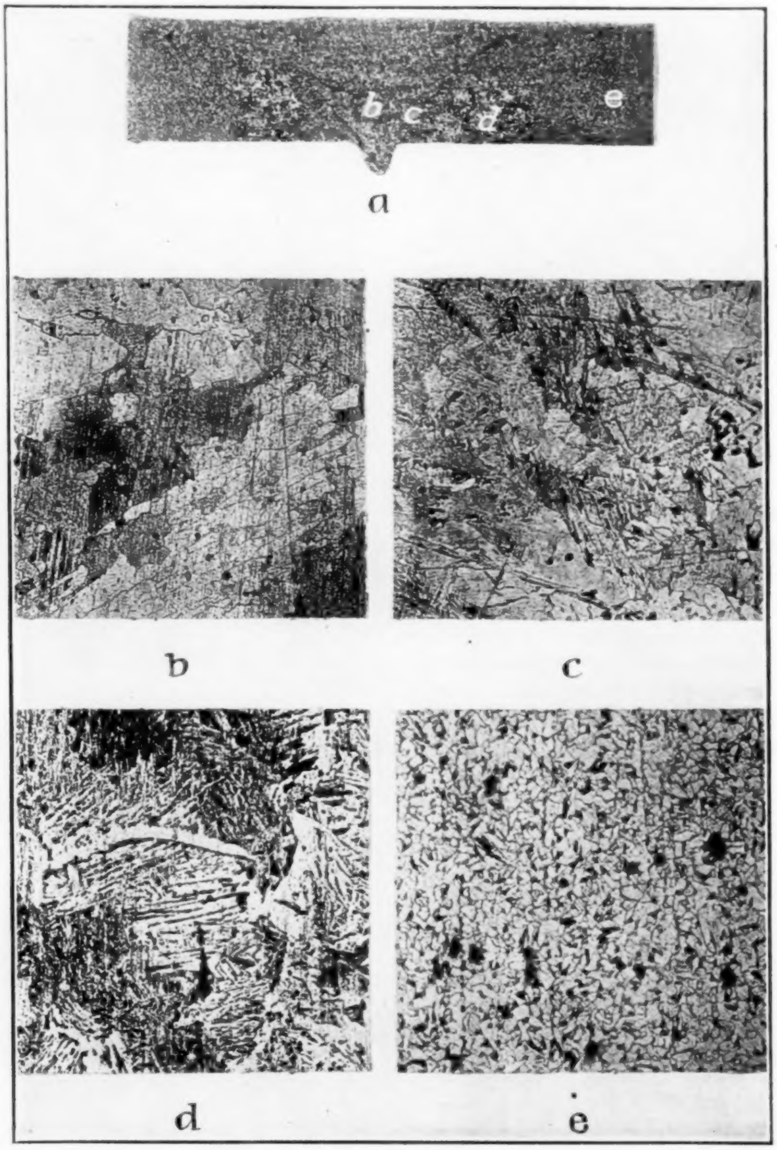



Fig. 8 Photomicrographs of Typical Weld

*a* Location of photomicrographs
*b* Fused-in metal of weld
*c* Junction of weld and plate
*d* Overheated metal of plate
*e* Initial or unchanged condition of metal of plate

Etched with 2 per cent alcoholic nitric acid. Magnification, × 50

## Discussion of Test Results

*The Welding Blowpipe.* It is universally accepted that outside of the mechanical features of design that affect weight, balance and convenience of operation, the prime essentials of a strictly satisfactory piece of apparatus are:

*a* Safety under all operating conditions

*b* Freedom from the so-called phenomena of "flashback" or sustained backfire

*c* The quality of maintaining under all operating conditions a welding flame that is neither oxidizing nor carbonizing, one technically known as a "neutral flame," which in the process of combustion consumes, as nearly as possible, equal volumes of oxygen and acetylene; that is, maintains as nearly as possible the theoretical gas-volume ratio of unity.

The tests of this investigation were decided upon with the idea of furnishing data that would enable blowpipes to be compared with respect to these essentials.

A study of the data obtained at the completion of the prescribed tests showed so many apparent inconsistencies that it was evident that there was a governing factor that was not understood, and that was, so far as test data were available, not in evidence. Irrespective of the fact that particular attention had been paid to insuring identical working conditions and gas-pressure control, and that especial care was taken to secure exceedingly competent and unbiased operators, the results obtained from the welding tests seemed extremely unsatisfactory. Gas ratios obtained during actual welding operations were extremely high. Those obtained when the blowpipe was burning freely in air were also higher than was to be expected. In tests for flashbacks there seemed to be a difference in the ease with which they could be developed in blowpipes of different manufacture, but there appeared to be no criterion that would enable one to say just why such phenomena could be caused more easily in some pieces of apparatus than in others, or why with some pieces of apparatus flashbacks could be produced at times quite readily and at other times with difficulty. Finally the general quality of the welds produced during test, although executed with the greatest care and shown by tensile tests to be of a higher strength than is generally secured in most welding shops, was far from satisfactory.

(*Continued on page 359*)

# The Design of Large Locomotives

## Features Which Keep an Engine in Service a Maximum Length of Time, Reduce Maintenance and Repair Costs, and Increase Revenue-Earning Power

By M. H. Haig,[1] Topeka, Kan.

*After discussing various restrictions and limitations in the design and construction of large locomotives due to the inability of existing bridges and tracks to carry the necessary weight and because dimensions must be governed by clearances of bridges and structures, the author expresses the opinion that the physical conditions of a road should be adjusted to the requirements of the locomotive, and that the only controlling factors should be the size of train and the traffic of the territory.*

*Leading features of locomotive construction such as relative size of cylinders, total heating surface, grate area, principal dimensions, etc., have been treated at length by various writers. Features which have not been so discussed, however, are those which keep a locomotive in service a maximum length of time, reduce engine failures to a minimum, reduce cost of maintenance and repairs, and increase revenue-earning power. And it is in order to arouse interest in those details which are not always given the attention to which they are entitled, and in the quality of material entering into the construction of locomotive parts, that the author proceeds to their consideration. These, in the order of their treatment, are: Counterbalance, crossheads, driving wheels, crosshead pins, piston rods, cylinders, frame braces, boiler cracks, back flue sheet, grate rigging, water columns, cab equipment, and tender capacity. The author's opinions on these topics are presented in the hope that discussion will bring out the experience of others not only on these but on additional details of locomotive design and construction.*

The design of a large locomotive depends on the service to which it is to be assigned. The service varies with the weight of the train to be hauled and the number of cars in the train, and is affected by the topography of territory on which it is to operate, ruling grades in each direction, length of grades, average speed between terminals, method of dispatching, whether single or double track between terminals, etc. This information being available, it is a reasonably simple matter to determine upon the leading features of a locomotive to meet the requirements.

### Restrictions and Limitations Imposed

For a locomotive to give practically 100 per cent service, its design and construction must not be restricted by personal opinion or by physical limitations of the road. If the weight needed for adhesion in starting a given train is restricted by an opinion that certain wheel loads should not be exceeded or because bridges and track are not capable of carrying the necessary weight, then the capacity of the locomotive is restricted and the train must be adjusted to the locomotive, instead of the locomotive being built to suit the train. This in turn has a tendency to limit a division or a railroad as a whole. Limitations such as these, together with clearances of bridges and structures, obstructions along the right of way, etc., affect the locomotive design and construction. The locomotive as a whole is dwarfed, or some of its vital or essential parts are so dwarfed as to cripple the machine as a whole.

A railroad is a plant, establishment or organization for manufacturing transportation. The locomotive is a very important part of the plant and is one of the most direct earners of revenue from which the transportation-manufacturing plant obtains its income. As such, it is a matter of business and economical principle to adjust some of the physical conditions of the road to meet the requirements of the locomotive, to prevent dwarfing it and to prevent sacrificing its power. Meeting these requirements of the locomotive amounts to meeting the necessary requirements of traffic. No turntable installed at a principal roundhouse should be less than 100 ft. long, and in many cases the length should be 125 ft. The distance between the walls of a modern roundhouse should be great enough to permit closing the door behind the tender of a Santa Fe or Mikado type locomotive and have ample room for trucking between the locomotive pilot and the outer wall of the roundhouse. Passing tracks should be long enough to take trains justified by the business and traffic of the division or territory. Bridges, rail and roadbed should be capable of carrying a static wheel load of at least 65,000 lb. per pair and of permitting the additional stresses resulting from a freight speed of at least 45 miles per hour. In meeting the requirements of rail stresses particular attention should be given to the employment of heavy rails on curves.

Unless these physical conditions are provided, a locomotive cannot be designed and constructed without restriction and proper power cannot be furnished to meet requirements. The only governing factors should be the size of train and the traffic of the territory.

### Leading Features of Locomotive Construction

Leading features of locomotive construction such as relative size of cylinders, length of stroke, total heating surface, superheating surface, grate area, etc., have been well covered by handbooks and pamphlets issued by locomotive builders and by reports to the various associations, as well as by articles in the technical press. Tables of principal dimensions of large locomotives are obtainable from the same sources, together with detailed descriptions of features of design and construction which have met with general favor and some which have been short-lived. A discussion or comment on these features would therefore be largely a repetition of facts already presented and easily available.

Features which have not been so generally discussed and exploited are those which keep a locomotive in service a maximum length of time, reduce engine failures to a minimum, reduce cost of maintenance and repairs, and increase revenue-earning power. Among these, durability of material and accessibility of parts are important factors. The latter implies arrangements by which a locomotive is made free from complicationsin construction, inexpensive to repair, easy to maintain, and so put together that needed repairs can be made handily and quickly.

Almost as important as providing a locomotive that will meet the requirements of trains to be hauled and traffic conditions, is providing one that requires minimum repairs—a locomotive that after one trip is ready to be turned for the next trip.

A locomotive is in revenue-earning service only when it is hauling trains. Any road can make a study and determine what proportion of its locomotives are unserviceable and what percentage of the time its serviceable locomotives are on the road. Such information will show what percentage of the time its engines are earning revenue.

To maintain the advantages of designs already existing and to develop these still further requires the unlimited coöperation not only of the mechanical, civil-engineering and operating forces of the railroads, but also of the locomotive builders, and particularly of the manufacturers of material.

The necessity for unlimited coöperation by manufacturers of material is evident from the study of failures of parts both large and small. On the principle of encouraging further consideration of such coöperation by all concerned and for the purpose of arousing interest in those details of locomotive construction which are not always given the attention to which they are entitled, a number of details which seldom appear among "leading dimensions" will be discussed.

### Counterbalance

Important among such details and one which is affected particularly by designers and manufacturers of material, is the counterbalance. The blow from the counterbalance is caused by the differ-

[1] Mechanical Engineer, Atchison, Topeka and Santa Fe Railway Company.

Abstract of a paper to be presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be obtained upon application. All papers are subject to revision.

ence between the weight of the revolving parts carried by the pins and the total weight in the wheel to balance both the revolving and reciprocating weights. In other words, it is the weight in the wheel to balance reciprocating weight that causes the hammer blow.

Weight of reciprocating parts therefore affects hammer blow of driving wheels, riding qualities of locomotives, possible damage to track and bridges and total weight of locomotive. It is particularly essential to make these parts as light as possible, and to make them light the material must be durable.

Due to the increase in weight of locomotives and to the hammer blow on rails when reciprocating parts are heavy, the 1915 Committee of the American Railway Master Mechanics' Association made the following recommendation:

Keep total weight of reciprocating parts on each side of locomotive below $^1/_{160}$ part of total weight of locomotive in working order and then balance $^1/_2$ weight of reciprocating parts.

An attempt to counterbalance large locomotives in both freight and passenger service according to this recommendation has demonstrated its merit, but has further demonstrated that the durability of both cast and forged steel must be improved if the method is to be continued.

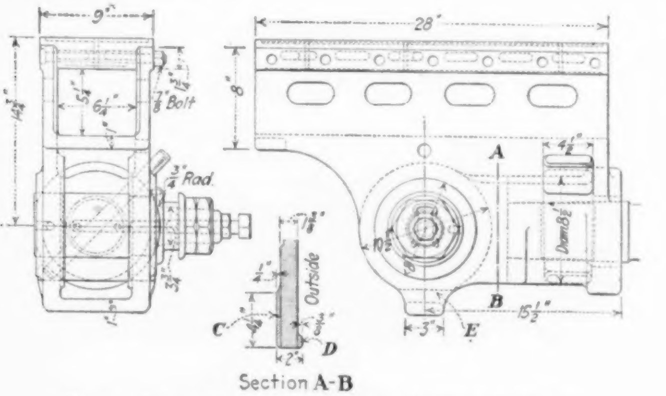



Fig. 1 Laird Crosshead Used on Various Types of Large Locomotives

### Crossheads

The Laird type of crosshead is lighter than several other designs, its performance is very satisfactory in service, and it therefore has advantages in designing for light reciprocating parts. A crosshead of this type used interchangeably on large freight and passenger locomotives is shown in Fig. 1.

The construction originally employed is shown by the figure, with the exception of later reinforcement at *C*, *D* and *E*. After about a year's service these crossheads began to break, the weakness appearing in the relatively thin wall between the hub around the piston rod and the lighter hub around the crosshead pin. The same weakness developed in crossheads of similar general design among locomotives of three or four different classes. The defects which proved common to these different crossheads are shown in Fig. 2.

By breaking up these crossheads in order to investigate the nature of the metal, it was found that in most cases each fracture had its origin in a shrinkage crack. The metal in most of the broken crossheads was found to be porous and to contain blowholes or gas holes, or shrinkage cracks, cold shuts or pipes. In some cases all of these defects were present.

Fig. 2 shows very clearly the difference in cross-section of the metal at and near the break. This difference is no doubt largely responsible for the defects in the metal which have caused an epidemic of failures. Crossheads of this general design have been used for many years, and as it appears impossible to modify the shape to advantage, the question, then, is whether foundries can adjust their practices to cast such irregular sections without blowholes, shrinkage cracks and other defects. This is one of the opportunities for manufacturers of material to coöperate with the locomotive designer.

### Driving Wheels

Another irregular section which causes shrinkage cracks is the cast-steel driving-wheel center. Rims and spokes are of much lighter section than the hub and counterbalance, and shrinkage cracks are not unusual at the juncture of these light and heavy sections. Foundries which cast locomotive parts have these conditions to meet and it is believed that foundry practices can be adjusted to meet them.

### Crosshead Pins

In the development of locomotive construction within recent years the union link of outside valve gears has been connected direct to the crosshead pin. This reduces weight by eliminating the crosshead arm and by shortening the length of the combination lever, thus lessening reciprocating as well as total weight. A further advantage is in eliminating the bolted connection between the crosshead and arm.

In eliminating the crosshead arm the duty of the crosshead pin is increased. A broken crosshead pin is more serious than a broken crosshead arm. When a pin breaks there is a possibility of something else being broken and a very great probability of a cylinder head being knocked out and carrying a part of the cylinder wall with it. It is therefore absolutely necessary that the material in the crosshead pin shall be of a good quality, and the steel used should contain about 0.50 per cent carbon and have a tensile strength of 80,000 lb. per sq. in.

By reference to Fig. 1 it will be observed that the diameter of the union link shank of the crosshead pin is $3^3/_4$ in. This is believed to be considerably larger than usual in locomotive design. Even

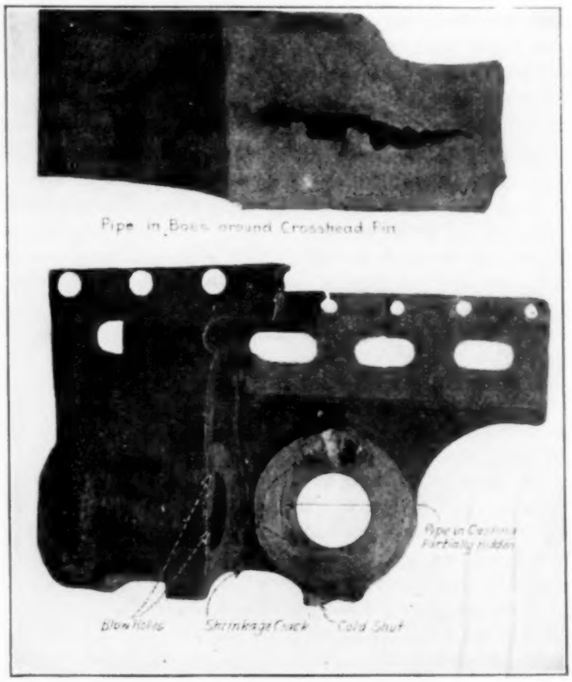



Fig. 2 Location and Nature of Defects in a Poorly Cast Crosshead

though the stresses in the crosshead pin are low, this large size appears to be a necessary precaution against the uncertainty in quality of material. As a further precaution there is a $^3/_4$-in fillet at the end of the shank.

### Piston Rods

The greater number of breaks in piston rods of at least one railroad have been through the keyway. Next in order is the location in the crosshead fit adjacent to the collar. Breaks in the body are usually adjacent to the collar at the crosshead fit and occasionally at the collar adjacent to the piston-head fit.

The mechanical fit between the rod and the crosshead is often responsible for the breakage of the former. If there is not a good bearing throughout the length of the fit or at both ends of it, there is opportunity for a slight movement of the rod in the crosshead. This starts a crack which gradually progresses into a fracture. To facilitate making a good bearing at both ends of a piston-rod fit

in a crosshead, the diameter is reduced $^1/_{16}$ in. for a length a little greater than the keyway and about midway between ends of the fit. To prevent cracks starting in sharp corners at edges of the keyway, these edges are chamfered at both ends of the keyway and entirely around.

Rods with comparatively low stresses sometimes fail in such a manner that it is difficult to attribute a cause unless quality of material is responsible. This is true of rods of ordinary carbon steel as well as those of specially refined steel and of alloy steels. In this is another opportunity for the assistance and coöperation of manufacturers of material.

### Cylinders

Failures of parts such as those described in preceding paragraphs, quality of material, uncertainty of cylinder cocks being operated, extreme variation in temperature due to use of superheated steam, foundry practices, etc., all affect the design of cylinders. Consideration of these and other features has resulted in the development of the design shown in Fig. 3, which is that of the cylinder of a Mikado locomotive. Except for modifications in dimensions this represents cylinders used also on Santa Fe, Mountain, Pacific and other locomotive types. The principal features of this cylinder are:

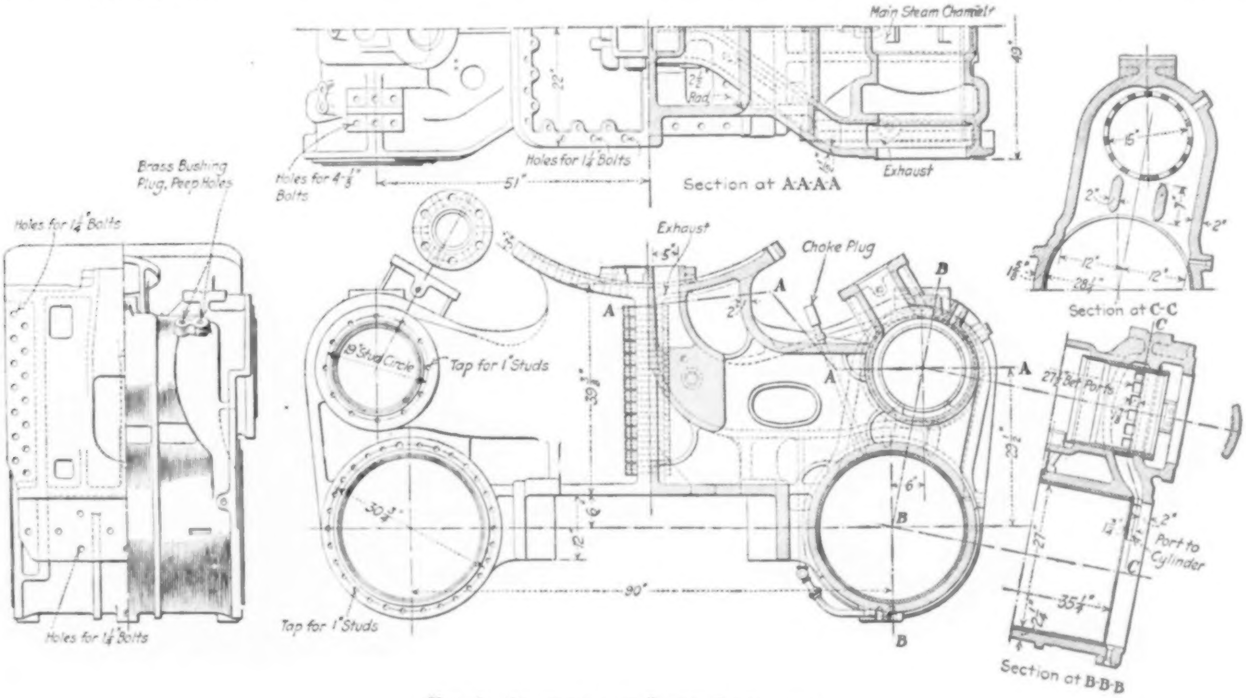



Fig. 3 Cylinder for Large Locomotive

- Simplicity in construction
- Uniform thickness of metal
- Absence of heavy metal sections at junctions of walls
- Walls and parts of ample thickness for strength, well ribbed, well braced and arranged with easy curves and generous fillets
- Uniform sectional area throughout length of steam and exhaust passages
- Short steam ports
- Small steam clearance
- Sections of metal, fillets and other features arranged to eliminate internal stresses set up in metal when cooling
- Double row of splice bolts holding halves of cylinder saddle together
- Double row of bolts at smoke arch
- Triple row of horizontal bolts securing cylinder casting to frame
- Depth of saddle casting directly above frame forming a box section and providing strength where shallow castings used with double-frame rail failed in the past
- Location of valve close to cylinder, permitting short ports, straight valve gear without offsets, and application of nearly straight steam pipe
- Large openings to cylinder cocks.

The steam and exhaust channels are free from obstructions and restrictions which will interfere with free flow of steam. The exhaust channels are gradually reduced in area from valve bushing to base of exhaust pipe in such a manner that the cross-sectional area of any point in the channel is not larger than any area through which exhaust steam has previously passed.

A weakness in castings of some large cylinders has been in the wall around the live-steam port. As shown in Fig. 3, this wall is made 2 in. thick and the distance across the port below the valve bushing is 24 in. To reduce stresses in this wall it has been made thicker than most other walls of the casting and, compared with former practice, width across port has been reduced about 4 in. The bridges in the live-steam port are 2 in. thick. They were formerly but 1 in. in thickness and it was not unusual to find them cracked clear through. The change was made to increase the cross-section of the bridges in relation to the adjacent walls and thereby reduce tendency to shrinkage cracks.

To obtain a good cylinder casting from any design, it is necessary to have proper coöperation of the pattern shop and the foundry. Patterns must be well built and carefully checked. The checker should exercise especial care to see that patternmakers apply all the fillets called for. The foundry should so arrange the mold as to obtain uniform sections of metal. To insure this, careful measurements should be taken when cores are being set and a drop light should be let down into the mold when taking measurements.

### Frame Braces

Locomotive frames are subjected to repeated lateral and twisting stresses, as well as to various other stresses, which will gradually break a single frame, but which can be withstood indefinitely by the application of substantial braces. An example of a pair of strong frames substantially braced is shown in Fig. 4, the arrangement illustrated being for a Santa Fe type locomotive. Bracing in the manner shown has been used for a number of years very successfully, and with very little modification is applicable to any locomotive class with outside valve gear.

Braces must be bolted to frames securely. Where braces or castings of other parts are bolted to a frame, the bolts should be applied with the head end bearing in these parts and not the thread end. This will provide for bearing on the bolt through the full thickness of the part bolted to the frame.

### Boiler Cracks

In using the boiler to supplement the frames in forming a backbone or foundation from which to brace machinery parts, the boiler

shell is subjected to additional stresses which result in cracks in the sheets. The most frequent causes of these cracks are guide-yoke braces, valve-motion braces and the ordinary belly braces to frames. Guide-yoke and valve-motion braces are often very stiff and are bolted securely to the frames and studded to the boiler. When the boiler expands the braces and connections are held rigidly by the frame and there is a tendency for the boiler to tear itself loose from these fastenings. This sets up strains in the metal which are aggravated by the vibration and pounding to which braces are subjected.

In an effort to overcome these cracks, outside welt plates have been riveted to the boiler to reinforce it where the brace pads are studded on. Experiments have been made with flexible, or partially flexible, braces, some of which have so far been successful.

On engines where breakage of braces has occurred, some of them are being replaced by braces with a pin connection at the lower as well as upper end. Where the use of pins is not favored, however, a thin plate in connection with a cast-steel brace should provide sufficient flexibility for expansion of the boiler and proper stiffness for bracing machinery parts.

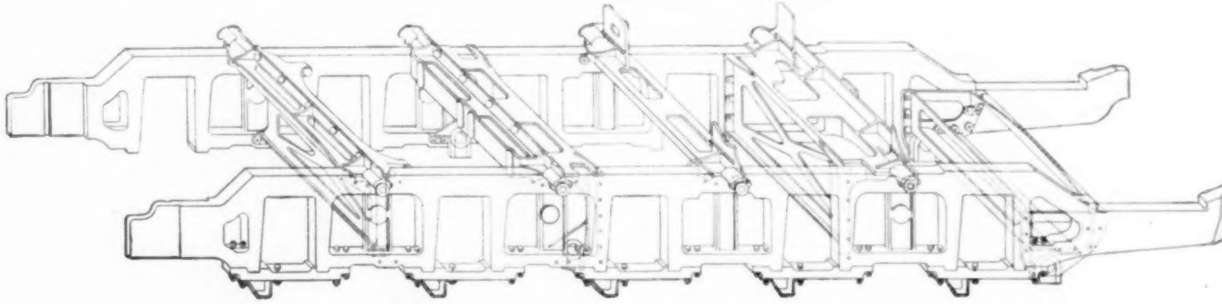


Fig. 4 Frames and Frame Bracing of a Large Locomotive

### The Back Flue Sheet

Boiler back flue sheets of large locomotives are renewed and patched more frequently on account of cracks in the knuckle near the top flange than from any other cause. On at least one road the average life of flue-sheet knuckles is 3 years and 3 months, the maximum and minimum varying within rather a large range.

A minimum limit of distance of top flue holes from top of flue sheet that is considered practical is shown in Fig. 5. To omit flues near the top of the flue sheet sacrifices heating surface. To raise the top of the flue sheet above the usual location of flues increases the weight in the firebox, adds to the amount of water necessary to cover the crown sheet, and by requiring increase in diameter of boiler to maintain steam space above the crown sheet, increases the weight of the boiler and consequently the weight of the locomotive as a whole.

Considering the stresses and the peculiar punishment to which flue-sheet knuckles are subjected, it is important to specify this material carefully. The following limits have been demonstrated by experience as practical:

| | |
|---|---|
| Tensile strength | 52,000 to 60,000 lb. per sq. in. |
| Elongation | Not less than 25 per cent |
| Carbon | 0.12 to 0.25 per cent |
| Sulphur | Not over 0.025 per cent |

### The Ashpan

Various details at the rear of a locomotive should be arranged to permit a large ashpan with smooth slope sheets at an angle that will permit cinders to fall to the hopper without obstruction, and its design should be decided on before the designs of surrounding parts have progressed too far. Equally as important is area between the ashpan and mud ring or through parts of the pan, to admit air to support combustion. This area should be at least equal to the area through the boiler flues, and preferably a little greater.

### The Grate Rigging

The place for grate rods, which operate the grates, is near the center of the grates and above the deep portion of the ashpan. On locomotives without stokers this arrangement is not difficult to provide for. With some stokers, however, grate rods in this position are interfered with, and this has resulted in some grate rods being located along the sides of pans, in certain cases very close to the flat portion or shelf of the pan under the mud ring. In this position the rods collect cinders close to the air openings and obstruct the admission of air for combustion. With steam grate-shaker equipment and stoker the grate rods can be located near the center of grates by applying a set of intermediate rockers.

### Water Columns

A very thorough investigation into conditions affecting the performance of water columns indicates that the most satisfactory serivce is obtained with a column and connections conforming with the following specifications:

| | |
|---|---|
| Inside diameter of water column | $3^1/_2$ in. |
| Inside diameter of top steam pipe | 2 in. |
| Inside diameter of connection of column to top steam pipe | Not less than 2 in. |
| Inside diameter of bottom connection to boiler | $^3/_4$ in. |

Top steam pipe as short as possible consistent with required location forward of boiler back head flange

Minimum number of bends in top steam pipe to column. This pipe to be lagged

No valves between water column and boiler either in top steam pipe or in bottom connection

Water-column bottom connection should extend into boiler far enough to clear nearby T-irons or other obstructions, approximately $4^1/_2$ in. from inside of sheet.

### Cab Equipment

The back wall of the cab should be far enough away from the boiler back head to give room for a satisfactory seat, for the application of the required equipment, and for a man to pull the throttle open without striking his arm against it. A distance of 46 in. from the face of back head at the center of fire door to the back wall of cab will meet these requirements.

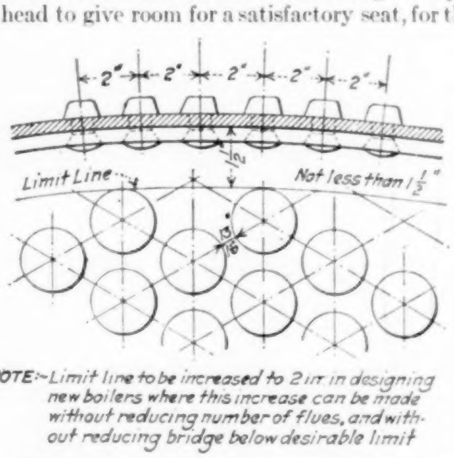



Fig. 5 Minimum Distance Between Top Row of Flues and Flange of Back Flue Sheet

Engineers' and firemen's seats should be located where the men can see ahead and their vision should not be obstructed by air pumps located too high, classification lamps misplaced, running boards too high at the front, or other obstructions that might interfere with their seeing semaphores, switch stands, etc.

(Continued on page 326)

# Dry-Vacuum Pump Capacity Tests

## Description of New Method Employing the Low-Pressure Nozzle for Air Measurements—Typical Volumetric-Efficiency Curves

By SNOWDEN B. REDFIELD,[1] EASTON, PA.

*The method of testing moderate-vacuum pumps described in this paper has a number of advantages. The nozzle used discharges into a back pressure which is greater than the critical. This permits the determination of several values of volumetric efficiency over a range of vacua without changing the nozzle. The method of plotting of results described by the author is a graphic proof of the accuracy of the theory involved and permits ready estimation of approximate performance of a given pump.*

CAPACITY tests of dry-vacuum pumps are not common and their actual volumetric efficiency at a given vacuum is usually a matter of conjecture. Furthermore the characteristic curve illustrating the law of the change of volumetric efficiency with vacuum is but little known. It is the purpose of this paper to describe a simple, practical and undoubtedly accurate method of testing dry-vacuum pumps by means of the low-pressure nozzle and to show the characteristic curves of one kind of pump as manufactured by the Ingersoll-Rand Company. The pump illustrated and tested is but one of many similar all-plate-valve pumps tested by the writer. It is not built for extremely high vacua, but is intended for that extensive class of service met with in many industrial and chemical processes calling for what is known as a "moderate vacuum."

Although it is not always appreciated, it is a fact that a dry-vacuum pump is only a compressor working through a range of pressures low down on the scale. Every compressor is really a "booster," that is, it takes in its air or gas at one pressure and compresses and delivers it at a higher pressure. The intake may be at any pressure below atmosphere, exactly at atmosphere, or even a hundred or more pounds above atmosphere. Similarly the discharge pressure may be anything, as long as it is above the intake pressure. In all cases the cycle of intake, compression and discharge is essentially similar, although the weight of material and the power required will vary widely according to the pressures.

### Nozzle Tests for Air Measurement

Within the last ten years tests for capacity of air compressors by means of the low-pressure nozzle have become quite common, and the measurement of air has long since passed from the realm of assumption to that of practically standardized methods of determination with considerable accuracy. This being true of the air compressor, it at once becomes true for the dry-vacuum pump, as they have just been shown to be members of the same family, and by methods similar to those standardized for the air compressors we may obtain the exact amount of air handled by a dry-vacuum pump at any vacuum.

Before going further, a word should be said in explanation of the terms "low-pressure nozzle" and "high-pressure nozzle." These are the popular terms to designate whether the back pressure into which the nozzle is discharging is above the critical pressure or below it, respectively. The critical back pressure for air is 0.53 of the upstream, or initial, pressure, and if the back pressure is above the critical, the expansion ratio is relatively low, so the nozzle may be called "low-pressure." If, on the contrary, the back pressure is less than the critical, the total expansion ratio is relatively high, and the nozzle is said to be a "high-pressure" nozzle. The following table gives the class of nozzle for various pressure ratios, assuming a 30-in. barometer:

As explained in many books on thermodynamics, if the back pressure is below the critical, the expansion in the nozzle is only down to the critical pressure in the throat of the nozzle and the rest of the expansion takes place beyond the throat without increasing the quantity of discharge. This immediately fixes the constant quantity of air a nozzle of a given size will pass from a given upstream pressure into any and all back pressures below the critical. For testing compressors with discharge pressures above 13 lb. gage, the nozzle discharging to atmosphere, different quantities of air may be made to flow through a high-pressure nozzle of a given

TABLE I CLASSIFICATION OF NOZZLES FOR AIR MEASUREMENT

| | Upstream Pressure | | Back Pressure | | Ratio of Back Pressure to Upstream Pressure | Kind of Nozzle |
|---|---|---|---|---|---|---|
| | Gage | Abs. | Gage | Abs. | | |
| For Pressure Work | 100 | 114.7 | Atm. | 14.7 | 0.128 | High-pressure |
| | 20 | 34.7 | Atm. | 14.7 | 0.424 | High-pressure |
| | 12 | 26.7 | Atm. | 14.7 | 0.551 | Low-pressure |
| | 2 | 16.7 | Atm. | 14.7 | 0.880 | Low-pressure |
| For Vacuum Work | Atm. | 14.7 | 2" vac | 13.75 | 0.933 | Low-pressure |
| | Atm. | 14.7 | 8" vac. | 10.80 | 0.733 | Low-pressure |
| | Atm. | 14.7 | 15" vac. | 7.36 | 0.500 | High-pressure |
| | Atm. | 14.7 | 26" vac. | 1.964 | 0.133 | High-pressure |
| | Atm. | 14.7 | 28" vac. | 0.982 | 0.066 | High-pressure |

size by changing the upstream pressure. This can be accomplished by maintaining the compressor discharge pressure constant in a receiver by means of a throttle which passes the air to the nozzle at some slightly lower pressure. The lower pressure beyond the throttle, at nozzle entrance, will adjust itself automatically to the quantity of air to be passed, so that considerable flexibility may be obtained for compressor testing with this class of nozzle.

Recently some capacity tests have been made upon vacuum pumps using a high-pressure nozzle. This is done by placing a nozzle in the wall of the vacuum vessel, drawing air from the atmosphere, and calculating the flow from well-known formulas. While this has been an assistance in some cases, it is not a flexible method and a different size of nozzle must be used for each vacuum at a given pump speed. This makes it a practical impossibility to test a vacuum pump at a specified vacuum, because one cannot tell just what size of nozzle will be required. With the "low-pressure" nozzle a given nozzle diameter may be used for a very considerable range of vacua and a capacity measurement may be made at any specific vacuum desired.

Due to the excessive noise of a "high-pressure" nozzle and the inaccuracies and difficulty of reading pressure gages of the spring type, the low-pressure nozzle with water-column pressure gage has been adopted by most of the leading compressor builders and is being incorporated into the new test codes of the Society now under revision.

Inspection of the table already given shows that as soon as the vacuum exceeds about 14 in. of mercury, a nozzle discharging from atmosphere into this vacuum is discharging into a pressure below the critical and we have at once a nozzle of the high-pressure class. We have already shown that a high-pressure nozzle of a given size discharging from a constant upstream pressure into a back pressure below the critical will pass only a constant air quantity, irrespective of how low the back pressure may become, and as in this case the upstream pressure remains atmospheric, the quantity of air passed will be constant for a given-sized nozzle for all vacua above 14 in. It then follows that the vacuum obtained with a given-sized nozzle of the high-pressure type, which passes a fixed quantity of air, can be changed only by changing the speed of the pump. If the pump speed is increased, the air must expand after it has passed the nozzle in order to fill the increased piston displacement, and this expansion must be accompanied by a reduction of pressure, which is the same thing as an increase in vacuum. Reduction of pump speed is accompanied by the reverse process and the vacuum will be decreased; but the fact remains that a high-pressure nozzle of a given size will pass only a constant quantity (weight) of air and will produce only one vacuum at a given pump

[1] Engineer in Charge Easton Engineering Dept., Ingersoll-Rand Company, Mem.Am.Soc.M.E.

Abstract of paper to be presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper can be obtained on application. All papers are subject to revision.

speed. Furthermore, it is impossible to select a nozzle of this type to test a given pump at a specified vacuum.

### Applying Low-Pressure Nozzle to Vacuum Pumps

As a more flexible and probably more accurate method of testing dry-vacuum pumps, the set-up shown in Fig. 1 lends itself well. In this figure the vacuum pump is drawing from tank $A$, and any desired vacuum may be produced in $A$ and the pipe connecting it to the pump by adjusting throttle $B$. Throttle $B$ is a globe valve provided with a long handle for close adjustment. Its stuffing-box gland is liberally daubed with heavy oil to insure against leakage. The running vacuum is observed on mercury column $E$, and, as said, this vacuum may be adjusted by $B$ to anything desired. Tank $C$ has in its end the nozzle $D$, taking air from atmosphere, and the pressure drop through $D$ is shown by the water column $F$. A thermometer $G$ shows the temperature of intake to vacuum-pump cylinder and thermometer $H$ shows the temperature of the air entering the nozzle.

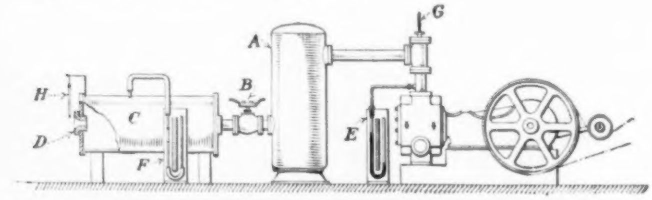



Fig. 1 Apparatus for Low-Pressure Nozzle Test of Vacuum Pump

We now see that the apparatus is composed of three parts: the pump to be tested; tank $A$ and piping in which any desired vacuum is to be maintained, measured by mercury column $E$ and thermometer $G$; and tank $C$, which by means of nozzle $D$, water column $F$, and thermometer $H$ measures the amount of air handled. As $B$ is adjusted, the quantity of air handled will change. This will change the vacuum as shown on gage $E$, and water column $F$ will also change to measure the new quantity of air passing through nozzle $D$. As the drop through $D$ is small, the pressure in $C$ is well above the critical at all times and the quantity of air passed will change with the slight vacuum in $C$, as measured by water column $F$. Thus there is a wide range of air quantities which can be made to pass through a low-pressure nozzle of a given size, and by proper adjustment of throttle $B$ any number of test points may be obtained as close together or as far apart as desired, independent of the speed of the pump. Furthermore, any specified vacuum may be secured at will, up to the limit of the machine.

### Formulas for Calculating Flow Quantities

For calculating the flow of a gas through an orifice or nozzle, the best-known formula for the case where the back pressure exceeds the critical is that which equates the energy on the two sides of the nozzle and assumes adiabatic expansion in the nozzle. This formula is given in all books on thermodynamics and most handbooks. As given by R. J. Durley[1] it takes the form—

$$W = A\sqrt{2g\,\frac{\gamma}{\gamma-1}\times\frac{P_1}{V_1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}}-\left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

where $W$ = weight of gas discharged per second, lb.
$A$ = area of cross-section of jet, sq. ft.
$P_1$ = pressure on upstream side of orifice, lb. per sq. ft.
$P_2$ = pressure on downstream side, lb. per sq. ft.
$V_1$ = specific volume of gas on upstream side of orifice, cu. ft. per lb.
$\gamma$ = ratio of specific heat at constant pressure to that at constant volume.

By transposition and substituting 1.406 for $\gamma$ and $53.4T/P_1$ for $V_1$, we obtain a workable formula for air, namely,

$$W = \frac{2.04\,AP_1}{\sqrt{T}}\sqrt{\left(\frac{P_2}{P_1}\right)^{1.425}-\left(\frac{P_2}{P_1}\right)^{1.712}}$$

where $T$ is the absolute temperature (deg. fahr.) on the upstream side of the nozzle.

This formula assumes frictionless flow and for practice a coefficient must be applied. This coefficient for a nozzle having a well-rounded entrance should be 0.97 for diameters below 1 in., 0.98 between 1 in. and 3 in., and 0.99 for nozzles over 3 in. in diameter. With larger nozzles the coefficient will remain very close to 0.99. This coefficient has been very carefully determined by Dr. Sanford A. Moss, as described in his paper on the Impact Tube.[1]

As $P_1$ is the upstream pressure and $P_2$ the downstream, the expression $P_2/P_1$ is less than unity and to raise this to a power is an awkward job. Also, as $P_1$ and $P_2$ are very nearly alike with a low water-column pressure, it is necessary to get the ratio to at least five places of decimals. Unless this is done the difference of the powers will not be correct and the air quantity will not be exact.

To avoid using numbers less than unity, it is more convenient to call $P_1/P_2 = R$, which is greater than unity; then raise the $R$'s to the required powers and subtract their reciprocals. By this procedure we obtain a more convenient formula, namely,

$$W = \frac{2.04\,CAP_1}{\sqrt{T}}\sqrt{\left(\frac{1}{R}\right)^{1.425}-\left(\frac{1}{R}\right)^{1.712}}$$

where $C$ = coefficient = 0.97 to 0.99
$R$ = ratio of absolute pressure on upstream side of nozzle to absolute pressure on downstream side of nozzle: $P_1/P_2$, expressed to at least five significant figures.

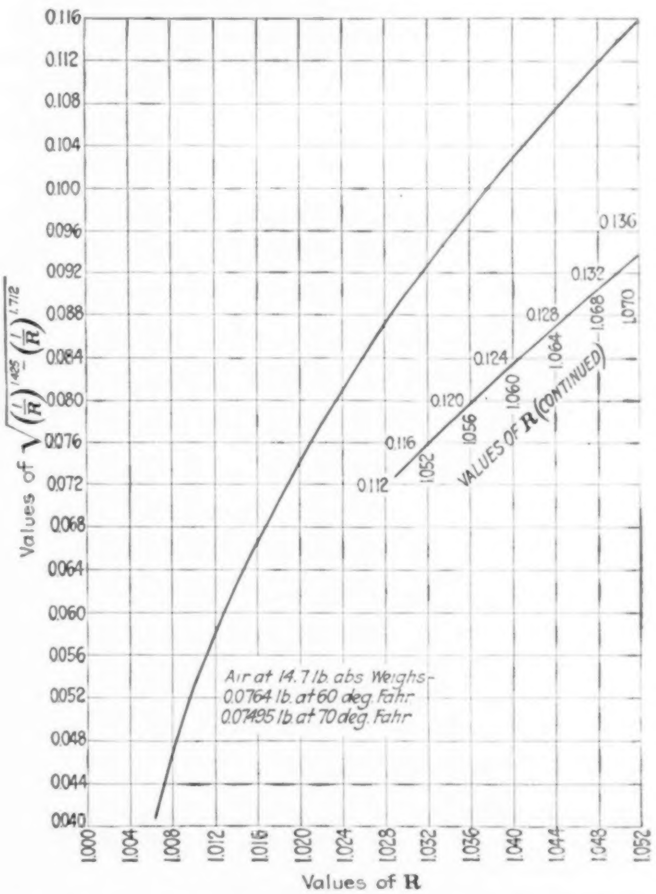



Fig. 2 Factors for Calculation of Air Flow by Rational or Energy Formula

Even with this modification it must be admitted the formula is cumbersome and for that reason the writer plotted the curve shown in Fig. 2. The abscissæ are values of $R = P_1/P_2$, which are therefore greater than unity, and the ordinates represent values of the complete radical $\sqrt{[(1/R)^{1.425} - (1/R)^{1.712}]}$. By means of this curve the process of figuring the weight of air handled is very greatly simplified.

After obtaining the weight per second, or per minute, of the air flowing, this should be changed to the volume handled by the pump so as to express it as a percentage of the piston displacement. To be perfectly logical, it should be expressed in cubic feet at the temperature of pump-cylinder intake as shown by thermometer $G$,

[1] Trans.Am.Soc.M.E., vol. 27, p. 195.

[1] Trans.Am.Soc.M.E., vol. 38, p. 761.

Fig. 1, and at the pressure of the cylinder intake, which is the vacuum shown by mercury column $E$. The cubic feet at this condition will be obtained by dividing the weight of flow calculated from the nozzle readings—water column $F$ and temperature at $H$, Fig. 1—by the weight per cubic foot of air at the absolute pressure of vacuum read on U-tube at $E$ and temperature measured at $G$, Fig. 1. The specific weight of dry air at any temperature may be calculated from the formula—

$$w = 0.1874 \frac{P}{T}$$

where $w$ = specific weight at the pressure $P$ and the temperature $T$, lb. per cu. ft.

$P$ = absolute pressure at which the specific weight is to be found, lb. per sq. ft.

$T$ = absolute temperature (deg. fahr.) at which the specific weight is to be found.

### Slide-Rule Formula

For those preferring to use a slide rule for calculation, the following formula, based upon the principles of hydraulic flow, but modified empirically, will yield values very close to the longer formula already given, provided the nozzle water column is not over 18 or 20 in. Below this limit the agreement is quite close at most points, but varying about one half of one per cent, being that much high around 8 or 10 in. and that much low around 20 in. water column. The formula, however, is so easy to use that it is preferable to the longer one, and at low water columns—around 4 in.—it is certainly more accurate, as the ratios in the longer formula then become too small for accurate calculation. The formula is—

$$Q = 3.64\, Cd^2 \sqrt{\frac{HT}{P_m}}$$

where $Q$ = cubic feet flowing per minute at absolute pressure of *downstream* side of nozzle and temperature shown by thermometer on *upstream* side of nozzle

$C$ = coefficient of flow = 0.97 to 0.99 as before

$d$ = diameter of nozzle throat (smallest section), in.

$H$ = observed nozzle water column, in.

$T$ = absolute temperature (deg. fahr.) shown by thermometer on upstream side of nozzle

$P_m$ = absolute mean pressure: that is, the average between the pressures on upstream and downstream sides of nozzle, lb. per sq. in.

As $Q$ will be expressed at pressure of downstream side of nozzle and temperature shown by nozzle thermometer on upstream side, it must be recalculated into volume at the vacuum shown by mercury column at $E$ and temperature shown by thermometer at $G$, Fig. 1, as before. This is, of course, done by changing the volume inversely as the absolute pressures and directly as absolute temperatures. It should be noted that this formula expresses $Q$ at downstream nozzle pressure, which is below atmospheric pressure by the amount of the nozzle water column observed.

### Plotting Test Results

So much for methods of test and calculation. The next important step is the plotting of the results, and here we meet a fact which is very convenient for the experimenter. This fact is, that if the quantities of air at various vacua handled by a pump at constant speed are calculated into volumes at *atmospheric* pressure and the temperature of the intake to the pump cylinder (thermometer $G$, Fig. 1), and if these are expressed as percentages of the elapsed piston displacement of the pump cylinder, we obtain what may be termed "atmospheric volumetric efficiency" and this will be very nearly a straight line when plotted against vacuum. In Fig. 3 is such a curve, as shown by the diagonal line marked Atmospheric Volumetric Efficiency. This was taken from a small pump designed for moderate vacuum. In this diagram abscissæ represent vacua in per cent of the observed barometer and ordinates represent percentage volumetric efficiency.

Having arrived at this very simple form of volumetric-efficiency curve, the ease with which points along the entire line may be read will be noted. This should be compared with the difficulty of reading the true volumetric-efficiency curve, expressed at conditions of pump-cylinder intake, especially at the higher-vacuum points. In this part of the curve the line becomes so steep that close reading is very difficult, and correct plotting is almost impossible. The slightest deviation to the right or left in drawing the high-vacuum part of the curve may make a difference of several per cent.

It should be noted that the volumetric efficiencies shown by both lines in the diagram, Fig. 3, are expressed at the temperature of pump-cylinder intake; that is, by thermometer at $G$, Fig. 1. This is correct because this is the temperature at which the pump receives the air. The only difference between the two curves is the pressure at which the air volumes are expressed. The temperatures being the same, the volumes are inversely as the absolute

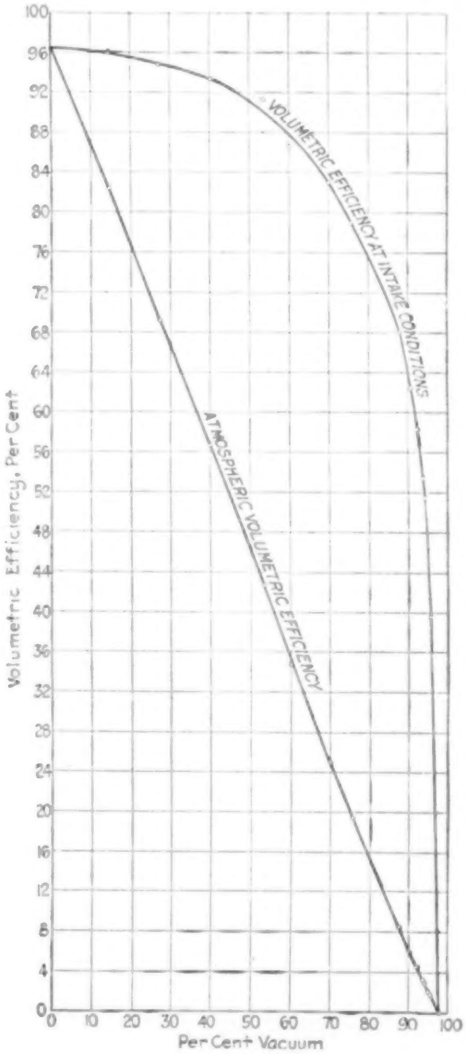



Fig. 3 Method of Plotting Volumetric Results

pressures, and as one of the pressures is atmospheric and the other the absolute pressure of the vacuum, the pressure ratio is simply the ratio of compression of the pump cylinder, provided the discharge is atmospheric. Therefore, with atmospheric discharge and having calculated and plotted the atmospheric volumetric efficiency, as shown by the diagonal, almost a straight line, the curved line of true intake volumetric efficiency may be obtained by multiplying the values on the diagonal line by the ratio of compression. Of course, if the pump discharge is not atmospheric, the values of the diagonal line should be multiplied by the ratio of the atmospheric pressure (barometer) to the absolute pressure of the vacuum at pump-cylinder intake.

Even after the true volumetric efficiency curve is plotted, it is usually easier and more accurate to obtain the true values by picking them from the diagonal line and multiplying these values by the pressure ratios. The steepness of the curve of true volumetric efficiency is too great to read accurately.

### Evidence of Accuracy of Nozzle Tests

Right here is an excellent opportunity to say a few words to convince the skeptical of the accuracy of the low-pressure nozzle as an instrument for the measurement of air, as exemplified by these vacuum tests. In such a test we have at the lower right end of the diagonal line, the point showing maximum vacuum with closed intake, that is, with no air handled and no nozzle at all. Following up the diagonal line, the next four points were obtained with a $^5/_8$-in. diameter nozzle with water columns progressing from just under 4 in. to about 13 in. The next three points above these were with a 1-in. nozzle with water columns from approximately $3^3/_4$ in. to about $12^1/_2$ in. After these points follow nozzles of diameters 1.75 in., 2.00 in. and 3 in. with water columns up to just under 15 in., each nozzle being able to handle several different quantities. In such a vacuum test, then, we always have a series of nozzles, beginning in this case with $^5/_8$ in. diameter and ending with 3 in. diameter, with water columns of several heights for each one, and in a very large number of tests which the writer has made, never has there appeared to be any visible break in the curve except what was well within probable experimental errors, showing where one nozzle size left off and the next size began. Considering that each smaller nozzle leaves off with a relatively high water column and the next larger diameter begins with a low water column and furthermore that the smallest nozzle links up with the point of no nozzle and no air, this is also a very good argument that the formula used for calculating the quantity of air expresses the law of nozzle action very well, indeed.

Another point should be noted, and that is that in such vacuum-pump tests the upper left end of the diagonal line which, by the way, is also the upper left end of the true volumetric-efficiency line (the pressure ratio being unity), shows volumetric efficiency around 95 and 96 per cent. As at this point the machine is taking in air with atmospheric intake and also putting it out at atmospheric pressure, under these conditions the pump cylinder really acts as a rough kind of displacement meter checking the nozzle. Of course, with the extra large amount of air being handled under these abnormal conditions, a slight compression takes place inside the cylinder producing a little heating and other small losses which prevent the volumetric efficiency from actually reaching 100 per cent of the cylinder volume. If the nozzle were to show over 100 per cent volumetric efficiency we would know it was inaccurate. So far the writer has never seen a case of this sort, which cannot be said of some other methods of test he has observed and results he has seen reported in all seriousness. Being just under 100 per cent, and sufficiently under to be justified by working conditions, appears to the writer to be a very good argument for those who are skeptical. Other more scientific determinations, notably those of Dr. Moss, prove the result beyond dispute; but these vacuum-pump test curves have always served to quiet the objections of those who lack scientific knowledge, but who require conviction by an obvious, though perhaps approximate, method.

### Effect of Valve and Piston Leakage

The effect of valve leakage has been mentioned as a cause for the departure of the atmospheric volumetric-efficiency curve from the straight line. It has been observed that with leaky valves the diagonal line will sag, especially at the high-vacuum or right-hand lower end. With appreciable valve leakage the line coming up and to the left from the closed-intake, maximum-vacuum point, will have a very decided bend in the first two inches of vacuum decrease. This bend in the line will be curved downward, which of course puts the curve lower for a given vacuum. When the points on this sagging diagonal line are multiplied by the ratio of pressures, as described, to obtain the true intake volumetric efficiency, this latter curve will simply lean further to the left. This means that the true volumetric-efficiency curve will not rise as rapidly as the curve corresponding to a diagonal atmospheric volumetric-efficiency line without sag. This again simply means that the true volumetric efficiency at a given vacuum will be lower, which naturally follows for a pump having valve and piston leakage.

With the above-described effect of leakage, it is clear that the true curves of a given pump cannot be drawn without actual nozzle-test measurements at several vacuum points near the maximum, as already described and illustrated in Fig. 3. For this reason any estimates based upon an assumed characteristic curve cannot be considered accurate, and if it is desired to be on the "safe side" without actual capacity tests, it is well to put an appreciable sag in the diagonal line used as a basis of estimation. This refers particularly to the upper two inches of vacuum.

The approved shapes of air-measuring nozzles will be described in the forthcoming air-compressor test codes now in preparation by the Power Test Codes Committee and the latitude to be allowed will be quite broad, just as long as the approach curve is well rounded. Special curves of compound radii have not been found to possess any particular virtue. All this is good news to the experimenter along these lines.

### Nozzle Shapes

Something must now be said about the shape of the nozzles used. Coefficients already mentioned were for nozzles having well-rounded approach surfaces. With nozzles of this kind the coefficient has been found to be much more stable than when an attempt is made to use a so-called "sharp-edged" nozzle. It is a practical impossibility to make a nozzle with a perfectly sharp edge and it has been found that with the slightest degree of bevel or rounding or other deviation from the perfect edge, the coefficient may vary widely. With the nozzle having a rounded approach it has been found that the coefficient will not change with change of approach radius within wide limits.

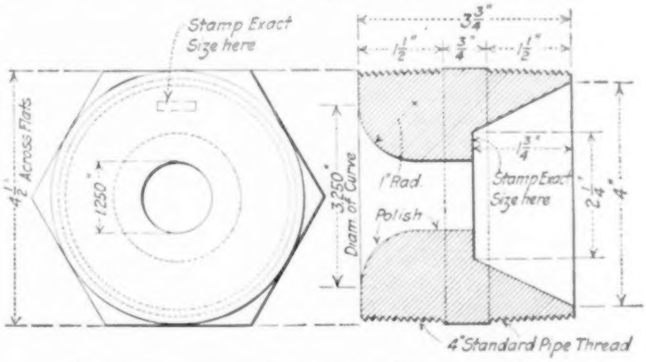



Fig. 4 Convenient Form of Air-Measuring Nozzle

Fig. 4 shows a very convenient form of nozzle. It is made with a pipe thread on both ends so that it can be used at will on the intake side of a vacuum pump, or on the discharge side of a compressor. The approach surfaces may have a radius of anything from 0.6 of the throat diameter, upward, with inappreciable effect upon the coefficient. The throat is followed by a straight or cylindrical portion. It is recommended that this be not less than $^1/_4$ the throat diameter, and it may probably be as long as the diameter without affecting the coefficient. Anything longer might bring in an additional friction influence to reduce the coefficient very slightly. A short straight portion has been found really essential to secure smooth flow.

### Nozzle on Discharge Side

In some cases it may be desirable to put the nozzle on the discharge side of the vacuum pump. There are two objections to this, although they are not very serious. First, to eliminate the pulsations of the discharge two tanks will have to be put in series, with the nozzle in the second tank discharging to atmosphere. This aggravates the second objection, namely, the compression ratio, which would necessarily be increased, and therefore reduces the volumetric efficiency of the pump. This back pressure will also be different for different vacua and nozzle sizes. Any throttling between the two tanks to remove pulsation makes this much worse, and if the pulsations are not removed the readings of the nozzle will be incorrect. No throttling or otherwise damping of the pulsations of the nozzle water column will help, as the error comes in the pulsations of the actual air passing the nozzle. Throttling on the intake side is just what is required to get the vacuum, so that, all things considered, the nozzle on the suction side is undoubtedly to be preferred.

# The Interpretation of Boiler-Water Analyses

By J. R. McDERMET,[1] JEANNETTE, PA.

*With the increasing use of economizers, higher steam pressures and higher rates of evaporation, it has become as necessary to consider the corrosive effects of a boiler water as its scale-forming properties, if not more so. Because of this the author has prepared the present paper, which discusses briefly the limitations and applications of a technical or mineral analysis; advocates the use of a partial sanitary analysis as forecasting possible trouble due to pollution; and indicates the significance of the analysis for dissolved gases in relation to the conditions under which the water is used. A laboratory-procedure sheet is appended to illustrate and make useful the facts discussed.*

THE chemist in performing a technical water analysis proceeds along conventional methods and by processes of evaporation, selective solution, precipitation, etc., determines quantities which he may submit for consideration directly, calculate into terms of elemental ions and ion radicals, or hypothesize into various chemical compounds which are assumed originally to have existed in the water. Irrespective of how results are submitted it is possible to calculate back into ion values, to which may be applied certain generalizations—with the reservations, however, that the values are arrived at initially by inflexible methods and are connected with the properties of the water only through deductive relationships.

The dissolved chemical compounds of a water which will ultimately become scale on the boiler surface are relatively slightly soluble in a physical sense. Chemically they are characterized as feebly hydrolyzed salts, and as such they are capable of very little dissociation in water—and then only into a very limited number of ions or electrified particles: namely, those of the salt itself and those of the dissociation with water.

Corrosive salts, on the other hand, are characterized as being both hydrolyzed and highly ionized, one of ions at least being that of a strong acid or base. If the chemist's ionization constants are applied to a group of these salts representative of a natural water, a bewildering series of relationships develops, due to the number of ions and their mutual effect in displacing the equilibria of each other. Such a procedure, however, is irrational for three reasons: (*a*) Ionization constants are experimental factors determined for normal temperatures only and are not necessarily valid at boiler temperatures. (*b*) The water molecule is of the form $(H_2O)_x$, and water in its transition from liquid to superheated steam undergoes a change of molecular grouping from the dihydrol into the monohydrol form. This transition is not abrupt at the change of state but gradual with rise of temperature. The monohydrol form which exists in small proportions at normal temperatures apparently occasions both the hydrolytic and dissociation phenomena. (*c*) Concentration of impurities in a boiler operating at high rating and high circulation velocity varies widely at different points in the circuit, the concentration increasing at regions where the water is abruptly accelerated. The rule of experience alone is applicable to those classes of impurities.

The laboratory-procedure outline appearing later in the paper employs the following basis of distinction: The values obtained in the analyses are computed into those compounds which form scale as far as the analytical values suffice. In this grouping abnormal silica is the only constituent which is capable of causing corrosion and its action is mechanical in permitting local overheating. To the remainder of the impurities limiting values are assigned, either on a percentage or an integral basis, the integral values being reserved for those constituents which are virulent. Sodium is ordinarily a fictitious quantity employed to balance combinations, but if the water analysis indicates a possibility of danger according to the criteria employed, a real value of sodium is determined and compensation is allowed for its presence. Sodium is so strongly basic in its chemical properties that its behavior in solution can be predicted with some exactness, and the hydrolyzed products of sodium salts are themselves inhibitors of corrosion.

It is only the relatively pure waters which produce dangerous conditions, and as the sum of dissolved solids decreases the liability toward corrosion disproportionately increases. Beyond an impurity content of 300 parts per million, corrosive waters are almost invariably of abnormal chemical analysis so that the danger is immediately apparent. Below 50 to 60 parts per million, the technical analysis, even if it shows no unfavorable features, is usually insufficient unless the history of the origin of the water is definitely known. For such waters a sanitary analysis is a distinct contribution.

### The Sanitary Analysis

The sanitary analysis is more truly a series of tests in which the reaction of the water is observed as indicative of the pollution which it has undergone, than a determination of foreign constituents. Technique has been so highly developed by the sanitary chemist that it is possible for him to tell from the values obtained in analyses the extent of the pollution and its sources—whether they be industrial, organic vegetable, or wastes from animal or human sources.

Industrial pollution usually manifests itself in the form of some characteristic compound which is a by-product of processes of manufacture. Aside from mine and paper-mill wastes, which usually reveal themselves unmistakably in the technical analysis, this class of pollution may occur in extreme dilution and yet be harmful in pure waters.

Under the heading of organic vegetable contamination may be grouped the products of algal growths, water plants in stagnant bodies of water, and the run-off from uncultivated land, particularly marshes, and deforested or forest fire areas. Chemically such contamination manifests itself either as acidity due to weak organic acids, or as nitrogen compounds. In the power plant the physical damage resulting from organic acids appears principally in the corrosion of saturated-steam lines, turbines, and vapor spaces of condensers; in other words, in apparatus where moisture accumulates from partial condensation. Unlike dissolved-gas contamination, the feed lines and boilers where the dilution of the acids is very great are reasonably exempt, and the corrosion does not exhibit its greatest vigor in a narrow zone of temperature. Undoubtedly the presence of dissolved oxygen accelerates the corrosion, but the organic acids polymerize or change their form rapidly and the action is not indefinitely cyclic as in the case of some mineral acids.

Nitrogen compounds—and in particular ammonia—originating in organic vegetable pollution confine their attacks principally to copper and brass fittings and the iron is exempt in the path of steam flow. In dead-end spaces serious corrosion may occur on both ferrous and non-ferrous metals, but aside from this the damage is usually inconsequential. Dissolved carbon dioxide in appreciable concentration due to bicarbonate alkalinity accelerates corrosion.

Sewage contamination may be classified as recent or remote, and further divided into household refuse and animal or human excrementitious matter. The latter, unless it exists in a quantity that contributes a dangerous chlorine content, sludges in the boiler and may be dismissed without further comment. Oleaginous matter and greases from household wastes if of recent origin contribute to foaming, priming and corrosion much as do organic acids if in considerable concentration. Sewage of remote origin which has been oxidized by aeration and bacteria action shows high nitrate content and sometimes nitrites, depending upon the extent of the natural purification. While the criteria in such cases are the nitrate content and the qualitative presence of nitrites, the introduction of both of these into a boiler water in any concentration is earnestly to be avoided.

### The Dissolved-Gas Analysis

The analysis for dissolved gases is confined entirely to the determination of dissolved oxygen. The position of dissolved carbon

---

[1] Research Engineer, Elliott Company, Assoc.Mem.Am.Soc.M.E.

Abstract of a paper to be presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

dioxide is anomalous. The researches of the author have been concerned with the simultaneous removal of carbon dioxide and oxygen, and are inconclusive; the published results of Speller[1] incline to the view that carbon dioxide in the absence of oxygen is not prejudicial. Cases where corrosion directly chargeable to carbon dioxide has occurred have usually accompanied a high-bicarbonate alkalinity or been complicated by ammonium compounds. It is probable, however, that increased rates of driving will compel an entire reversion of attitude toward boiler-water alkalinities.

Analytical methods for determining dissolved oxygen are available in standard chemical textbooks, and methods of manipulation adapted to the engineer's needs have been discussed in the technical press.[2] Methods for determining dissolved oxygen fortunately and unlike other analyses on water determine definitely and directly the constituent sought, and it only remains to apply the information intelligently to the elimination of corrosion problems. While deterioration of the ferrous metals results at all stages of the water and steam cycle where water and oxygen are present as such, in all but two cases which have developed in the writer's experience alleviation has been sought only for steel-tube or cast-iron economizers, boilers, or hot-water feed lines. The characteristic manifestation is the wasting of cast iron and pitting of steel surfaces, sometimes accompanied in the latter cast by a pseudo-stalagmite formation.

It is impossible with commercial pipe materials to formulate an opinion as to how long a hot-water boiler-feed pipe system will last. It appears, however, that if the oxygen content is kept below 0.7 cc. per liter (0.7 part in 1000 by volume), the gas volume being reckoned under standard conditions, the life of the feed lines will be of such a length as to prevent ascribing the ultimate failure to oxygen. It may be taken as axiomatic, however, that the reduction of oxygen content to the lowest consistent value is always a desirable precaution.

Boilers that operate below rating rarely suffer any damage, whatever may be the oxygen content of the feedwater. As the rating goes up, however, damage appears, but if the concentration is kept below 1.0 cc. per liter the boiler seldom experiences pitting action. Boiler scale is a fairly efficient protective agent against this form of attack. Unfortunately, scales of predominant silicate or pure sulphate composition introduce a different corrosion loss, in that there is an amalgamation at the boundary between the iron surface and the scale through the intermediation of iron oxide. The use of mechanical tube cleaners in removing this scale results in a severe detrition loss from the iron surfaces which may very markedly shorten the life of the boiler. The removal of oxygen from the boiler feed to the extent that existing apparatus is able to accomplish it, does away with this amalgamating action, and these classes of impurities in the absence of heavy carbonate formations become self-scaling.

Boilers rarely present simple corrosion phenomena. Usually trouble arises from a complexity of causes. Corrosive dissolved solids which yield free acid radicals and dissociated acid radicals and dissolved oxygen are mutually accelerants of pitting action. With such boiler waters the removal of dissolved oxygen is a worthwhile alleviation and a guarantee against regenerative action with a stable acid ion, but it is not a cure. Chemical treatment of the water is the most logical corrective if it is properly controlled and is not based on excessive alkalinities; but in practice the results obtained are usually far short of the ideal and need to be supplemented. The pitting of the surfaces presents the same general appearance. Where it is directly chargeable to dissolved gases the action is more or less selective, in that the area of greatest virulence is confined to parts where the circulation is sluggish, and entirely to the water space. In boilers subjected to severe acid corrosion, however, the pitting may extend into the steam space.

The corrosion of a cast-iron economizer likewise presents two aspects. The corrosion of cast iron in its initial stages is more rapid than that of steel, but the adhering residue products from the corrosion—graphitic carbon and silica—immediately form a protective coating which arrests further action. Cast-iron economizer corrosion is due to the continuous removal of the protective coating, has most nearly the appearance of erosion, and takes place in the headers and tube ends where water velocities are changed. This erosive-corrosive action will disappear if the oxygen content of the feedwater is kept below 0.7 cc. per liter, provided that the water does not deposit scale on the economizer surfaces. Economizers in the past have been principally waste-heat adjuncts operating between the extreme temperature limits of 90–250 deg. fahr., and if these limits are extended in future practice it will doubtless be necessary to lower further the oxygen value. Where the temperature and character of water combine to produce scaling on the cast-iron tubes which necessitates the periodical use of mechanical tube cleaners, the safe oxygen limit is automatically reduced to 0.3 cc. per liter. The tube cleaner not only removes the existing protective coating which has formed, but disturbs the surface layer so that a new one is slow in forming.

Jacobus and Speller independently and by different methods have established the value 0.2 cc. as the maximum oxygen content which will prevent accelerated corrosion in a steel-tube economizer. The allowable content which will permit the realization of a profitable operating life from the economizer may conceivably be lower than 0.2 cc. per liter, but this can be determined only after years of experience.

The most virulent steel-feed-pipe corrosion occurs between the temperature limits 180–200 deg. fahr; and no such range is exhibited by the steel-tube economizer. Water in its passage through and temperature elevation in the economizer gradually rejects a portion of its dissolved gases in the form of bubbles which cling to the tube wall and by coalescence establish for themselves a slower rate of travel than the water, whose velocity is materially below the region of turbulent flow. Besides materially reducing conductivity, these bubbles through their oxygen content both occasion the corrosion and distribute it over the entire surface.

The characteristic corrosion phenomena in the case of steel-tube economizers are pit holes. The primary cause for these may be exceedingly small pieces of imbedded mill scale or segregated impurities in the metal which form electric cells and occasion roughness, or an initial roughness on the surface to which the bubbles of gas adhere and produce minute air pockets. The appearance of a pit hole is accompanied by a stalagmite or barnacle-like growth of corrosion products completely covering the pit hole and projecting above the surface. These barnacle-like protuberances consist of three successive layers of iron hydroxides in the order of their proximity to the iron surface, $Fe(OH)_2$, $Fe_3(OH)_8$, and $Fe(OH)_3$, which in their dehydrated forms correspond respectively to the ferrous, black, and red oxides of iron. The hydroxide $Fe_3(OH)_8$ only is adherent, and constitutes the binder and the bulk of the volume. The growth of these projecting surfaces further arrests the bubbles and the electrolytic potentials accelerate the action, but all causes combine to keep it very localized. The result is a punctured surface.

## LABORATORY PROCEDURE IN WATER ANALYSIS

1 If the water originates with the Condenser Division as a water for circulation, perform (7), calculate according to (8), and report on this basis.

2 If the sample originates with the Air Separation or Research Divisions, perform the analysis according to the detailed procedure which follows. A memorandum from the chief of the division concerned will be issued covering as far as data permit the following facts:

*a* Purpose of the analysis
*b* History and origin of the sample
*c* Any physical observations which would direct a preponderance of suspicion toward peculiarities to be expected in the analysis.

3 Record all numerical results in parts per million (p.p.m.)

4 Record from observation in clean glassware qualitatively—

*a* Turbidity
*b* Presence of visible suspended matter
*c* Color
*d* Odor hot
*e* Odor cold.

(*Continued on page 342*)

[1] A Method for Practical Elimination of Corrosion in Hot Water Supply Pipe, F. N. Speller, *Jour. Am. Soc. of Heating and Ventilating Engrs.*, vol. 23, no. 9, January 1917.

[2] Simple Methods for Determining Dissolved Gas Content of Boiler Feed Water, J. R. McDermet and D. Wertheimer, *Power*, Nov. 2, 1920, p. 686.

# Boiler Tests with Pulverized Illinois Coal

By HENRY KREISINGER, MILWAUKEE, WIS.,[1] AND JOHN BLIZARD, PITTSBURGH, PA.[2]

*In this paper the author presents a summary of the results obtained in an extended series of tests of a 468-hp. water-tube boiler fired with pulverized Illinois coal.*

*The results show that, contrary to the customary specification, it is not necessary to pulverize the coal to the extreme fineness of 85 per cent through a 200-mesh screen in order to get good combustion and good efficiency. This ability to burn coarser coal means increased capacity of the pulverizing mills and decreased cost of coal preparation.*

*The results also show that it is not necessary to dry coal to about 1 per cent moisture in order to burn it successfully in pulverized form, and it is stated that with most eastern coals drying is not at all necessary.*

*Good results can be obtained when the coal is burned at rates varying from 0.5 lb. to 2 lb. per cu. ft. of combustion space per hour, and the best results at a rate of 1 to 1.5 lb.*

THIS paper gives the summary of the results of a series of 11 tests made on a 468-hp. Edgemoor boiler equipped with a Foster superheater and fired with pulverized coal at the Oneida Street Station of The Milwaukee Electric Railway and Light Company, Milwaukee, Wis. The tests were made by the Fuel Section of the U. S. Bureau of Mines in coöperation with the Research Department of the Combustion Engineering Corporation. The powdered-coal equipment was designed and installed by the Locomotive Pulverized Fuel Company. The coal burned in these tests came from the Illinois coal field. The object of the tests was to determine what overall efficiency can be obtained with pulverized Illinois coal under various conditions

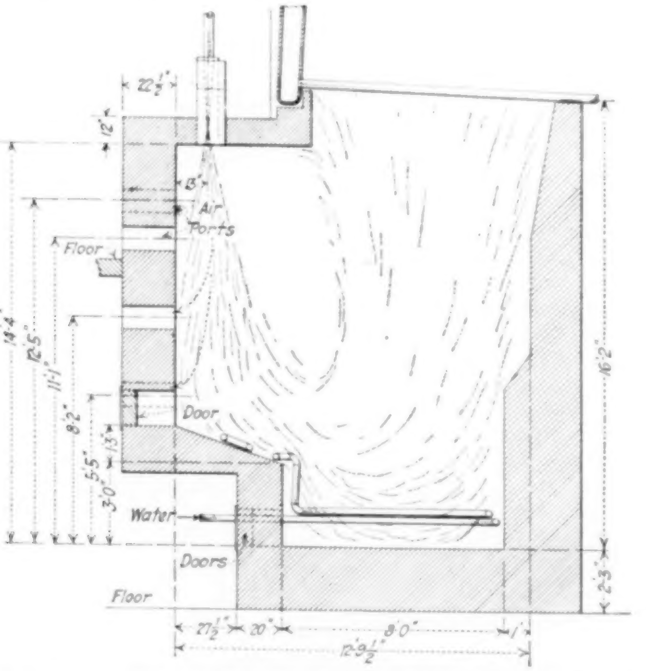



FIG. 1 SECTION THROUGH FURNACE, SHOWING ARRANGEMENT OF BURNER AND COOLING COIL OVER HEARTH AND NEAR BOTTOM OF FURNACE

of furnace operation and different preparation of coal as to degree of fineness and percentage of moisture.

The tests were made in a thorough manner, everything being done to make the results accurate and reliable. The pulverized coal was weighed in specially designed tanks placed on platform scales as it was supplied to the furnace. The tests were from 17 to 25 hours in duration.

Tests Nos. 28 to 30, inclusive, were made with the usual preparation of coal as it is burned in the plant under ordinary operating conditions. Test No. 31 was made with the same condition of coal as the three previous tests, but with the furnace provided with a cooling coil over the hearth and along the walls near the bottom of the furnace to facilitate the removal of ash. Tests Nos. 32 to 35, inclusive, were made with the same furnace arrangement as test No. 31, but with the coal pulverized to a lesser degree of fineness. Tests Nos. 36 to 38, inclusive, were made with the same furnace arrangement as in the previous four tests, but with undried coal.

Fig. 1 shows the arrangement of the burner and the cooling coil over the hearth and near the bottom of the furnace. The cooling coil consisted of three lengths of 2-in. pipe over the hearth and two lengths along the side walls and the rear wall. The total surface of the coil was 48 sq. ft.

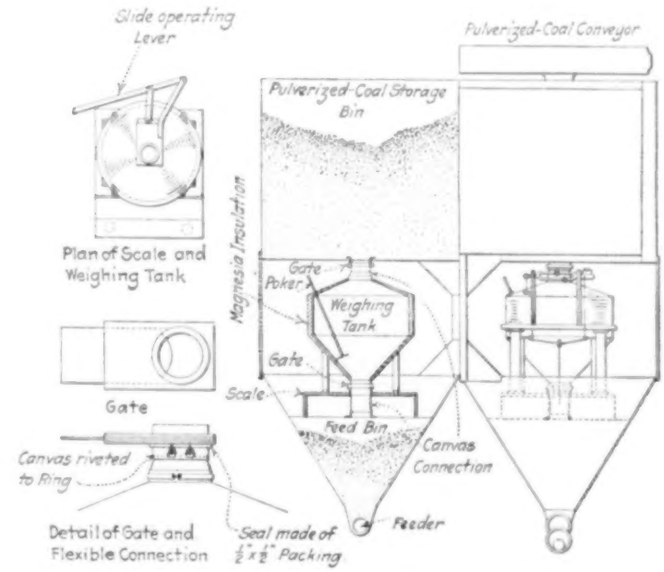



FIG. 2 COAL-WEIGHING APPARATUS USED IN TESTS

Fig. 2 shows the coal-weighing apparatus, which was placed between the storage bin and the feed bin. There were two burners and two feeders, and the coal to each feeder was weighed separately. The weighing tanks were connected to the storage bins and the feeder bin by flexible canvas connections to permit weighing and to prevent the coal dust from escaping into the room when the weighing tanks were filled and emptied. The tests were started and closed with the feeder bins empty.

The feedwater was weighed in two water tanks placed on platform scales. The water supplied to the cooling coil was measured by a 2-in. water meter which was calibrated at the rate of feeding the water through the cooling coil, and its measurements were found reliable to within less than one-half of one per cent.

Flue-gas samples were taken at six points in the uptake and collected over one-hour periods. Flue-gas temperatures were measured with thermocouples at the same six points where samples were drawn for analysis, and readings were taken every 15 min. The flue-gas temperature given in Table 1 is the average of the measurements with the six couples.

## RESULTS OF THE TESTS

The results of the tests are given in Table 1. The quantities of heat absorbed by the boiler, superheater and cooling coil, when the latter was used, are itemized separately. In the heat balance the losses by radiation are given by a separate item. In a series of tests on the same boiler and setting the radiation loss per square foot of exposed surface should be nearly constant and should vary only slightly by the capacity developed by the boiler. For the calculation of the radiation loss it was estimated that 250

[1] Research Engineer, Combustion Engineering Corporation.

[2] Fuel Engineer, U. S. Bureau of Mines.

For presentation at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

TABLE 1 SUMMARY OF RESULTS OF 11 STEAMING TESTS ON AN EDGEMOOR BOILER BURNING POWDERED COAL, AT ONEIDA STREET POWER STATION, MILWAUKEE, WIS.

Heating Surface:
Boiler.... 4680
Superheater.... 594
Furnace coil.... 48
Total.... 5322 sq. ft.

Draft—Natural
Burner—Lopulco vertical
Coal feed—Screw and air blast.

Rating of boiler.... 468 hp.
Volume of furnace.... 1660 cu. ft.
Greatest height of furnace.... 16.7 ft.
Greatest width of furnace.... 9.3 ft.
Greatest length of furnace.... 13.3 ft.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Test Number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| 2 Duration, hours | 22.90 | 23.72 | 18.17 | 23.62 | 23.60 | 22.47 | 25.22 | 23.53 | 23.43 | 23.33 | 16.73 |
| *Coal as Fired* | | | | | | | | | | | |
| 3 Per cent through 100 mesh | 96.10 | 95.80 | ..... | 95.40 | 93.20 | 93.10 | 90.80 | 88.60 | ..... | 94.40 | 95.40 |
| 4 Moisture content, per cent | 1.42 | 2.92 | 2.75 | 2.55 | 3.79 | 3.07 | 3.60 | 3.47 | 7.69 | 8.23 | 8.23 |
| 5 Volatile matter, per cent | 36.62 | 36.66 | 37.45 | 36.58 | 36.57 | 36.29 | 37.17 | 36.27 | 35.82 | 34.42 | 34.70 |
| 6 Fixed carbon, per cent | 48.16 | 46.63 | 46.08 | 48.07 | 48.43 | 49.01 | 46.39 | 48.87 | 45.74 | 46.39 | 44.67 |
| 7 Ash, per cent | 13.80 | 13.79 | 13.72 | 12.80 | 11.21 | 11.63 | 12.84 | 11.39 | 10.75 | 10.96 | 12.40 |
| 8 Sulphur, per cent | 2.66 | 3.64 | 3.49 | 2.92 | 2.40 | 2.66 | 3.43 | 2.99 | 2.10 | 2.21 | 2.90 |
| 9 Calorific value, B.t.u. | 11956 | 11860 | 11875 | 12085 | 12172 | 12178 | 11889 | 12188 | 11565 | 11508 | 11245 |
| 10 Total fuel fired, lb. | 40214 | 39862 | 52746 | 46613 | 43947 | 45469 | 47459 | 41250 | 43729 | 41640 | 36315 |
| 11 Coal fired per hour, lb. | 1756 | 1681 | 2903 | 1973 | 1862 | 2024 | 1882 | 1753 | 1866 | 1785 | 2171 |
| 12 Coal fired per hour per cu. ft. of combustion space | 1.10 | 1.05 | 1.81 | 1.23 | 1.16 | 1.26 | 1.18 | 1.09 | 1.16 | 1.12 | 1.36 |
| *Ash and Refuse* | | | | | | | | | | | |
| 13 Carbonaceous content in furnace slag, per cent | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 Carbonaceous content in 2d and 3d pass refuse, per cent | 4.15 | 3.49 | 5.00 | 5.25 | 9.52 | 7.19 | 7.52 | 7.37 | 4.97 | 4.32 | 4.49 |
| 15 Carbonaceous content in uptake dust, per cent | 4.95 | 5.24 | 7.35 | 5.13 | 7.70 | 6.45 | 7.81 | 5.57 | 3.91 | 3.50 | 3.28 |
| 16 Calculated total carbon in refuse, per cent of coal fired | 0.50 | 0.54 | 0.62 | 0.36 | 0.87 | 0.61 | 0.67 | 0.30 | 0.24 | 0.22 | 0.26 |
| 17 Softening temperature of coal ash, deg. fahr. | ..... | 2050 | 2210 | 2120 | 2120 | 2110 | 2060 | ..... | ..... | ..... | ..... |
| *Ash Account (per cent of ash fired)* | | | | | | | | | | | |
| 18 From bottom of furnace | 29.20 | 25.50 | 41.50 | 48.10 | 10.10 | 24.10 | 37.80 | 59.40 | 48.10 | 47.10 | 41.60 |
| 19 From 2d and 3d pass | 12.10 | 11.60 | 5.80 | 10.40 | 10.30 | 7.00 | 9.10 | 10.50 | 8.30 | 7.70 | 8.70 |
| 20 From dust collector | 31.50 | 25.00 | 33.20 | 29.20 | 27.50 | 29.00 | 25.50 | 30.10 | 32.80 | 26.00 | 26.30 |
| 21 Unaccounted for | 28.20 | 37.90 | 19.50 | 12.30 | 52.10 | 39.90 | 27.60 | 0.00 | 10.80 | 19.20 | 23.40 |
| *Air* | | | | | | | | | | | |
| 22 Temperature, air at furnace, deg. fahr. | 83 | 90 | 80 | 76 | 85 | 71 | 64 | 74 | 79 | 72 | 75 |
| 23 Pressure air at feeder, inches of water | 5.00 | 5.30 | 7.50 | 5.10 | 5.60 | 5.50 | 6.40 | 5.90 | 5.70 | 5.50 | 6.20 |
| 24 Excess air in flue gas, per cent | 30 | 22 | 18 | 18 | 19 | 15 | 20 | 25 | 19 | 16 | 20 |
| *Flue Gas* | | | | | | | | | | | |
| 25 Carbon dioxide, per cent by volume | 14.10 | 14.90 | 15.40 | 15.50 | 15.30 | 15.80 | 15.10 | 14.60 | 15.50 | 15.80 | 15.40 |
| 26 Oxygen, per cent by volume | 4.80 | 3.80 | 2.90 | 3.30 | 3.20 | 2.40 | 3.60 | 4.10 | 3.20 | 2.90 | 3.60 |
| 27 Carbon monoxide, per cent by volume | 0 | 0 | 0.26 | 0 | 0 | 0.10 | 0.10 | 0 | 0 | 0 | 0 |
| 28 Pounds of dry flue gas per pound of coal | 12.40 | 11.20 | 10.60 | 11.00 | 11.30 | 10.80 | 11.00 | 11.70 | 10.70 | 10.40 | 10.60 |
| 29 Temperature of gases in uptake, deg. fahr. | 517 | 492 | 610 | 483 | 457 | 472 | 470 | 486 | 484 | 466 | 514 |
| *Draft* | | | | | | | | | | | |
| 30 At uptake, inches of water | 0.12 | 0.10 | 0.27 | 0.09 | 0.06 | 0.08 | 0.05 | 0.09 | 0.10 | 0.05 | 0.15 |
| 31 Top of furnace, inches of water | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 |
| *Steam and Water* | | | | | | | | | | | |
| 32 Steam pressure, lb. absolute | 184 | 186 | 196 | 189 | 188 | 187 | 185 | 186 | 183 | 182 | 185 |
| 33 Degrees superheat | 60 | 59 | 80 | 58 | 53 | 61 | 67 | 79 | 74 | 70 | 102 |
| 34 Temperature of feedwater, deg. fahr. | 108 | 99 | 99 | 101 | 101 | 100 | 100 | 103 | 98 | 100 | 99 |
| 35 Temperature of water to coil deg. fahr. | | No coil | | 54 | 53 | 52 | 50 | 48 | 46 | 46 | 46 |
| 36 Temperature of water from coil, deg. fahr. | | No coil | | 129 | 146 | 145 | 118 | 151 | 139 | 130 | 144 |
| *Rates of Heat Absorption* | | | | | | | | | | | |
| 37 Per cent of builder's rating (boiler only) | 106.6 | 103.9 | 167.4 | 111.7 | 102.7 | 112.4 | 103.4 | 104.8 | 101.9 | 94.4 | 113.5 |
| 38 Horsepower developed (boiler only) | 498.8 | 486.5 | 779.0 | 523.2 | 480.8 | 526.0 | 484.0 | 490.5 | 477.0 | 442.0 | 531.5 |
| 39 Horsepower developed (superheater only) | 15.8 | 15.3 | 32.9 | 16.3 | 13.7 | 15.0 | 15.4 | 20.5 | 18.4 | 16.3 | 27.9 |
| 40 Horsepower developed (furnace coil) | | No coil | | 49.7 | 55.0 | 59.7 | 45.9 | 17.5[1] | 32.0 | 29.1 | 26.8 |
| 41 Total horsepower developed | 514 | 502 | 812 | 589 | 549 | 601 | 545 | 528 | 527 | 487 | 586 |
| *B.t.u. Absorbed per Sq. Ft. of H. S. per Hour* | | | | | | | | | | | |
| 42 By water in boiler | 3567 | 3482 | 5575 | 3743 | 3437 | 3758 | 3466 | 3508 | 3413 | 3207 | 3798 |
| 43 By steam in superheater | 892 | 861 | 1856 | 920 | 772 | 845 | 869 | 1155 | 1039 | 934 | 1573 |
| 44 By water in furnace coil | | No coil | | 33900 | 37600 | 40770 | 31270 | 33190 | 21920 | 20160 | 18440 |
| *Heat Absorbed per Pound of Coal as Fired, B.t.u.* | | | | | | | | | | | |
| 45 By water in boiler | 9500 | 9690 | 8990 | 8870 | 8630 | 8710 | 8625 | 9360 | 8560 | 8405 | 8190 |
| 46 By steam in superheater | 301 | 304 | 380 | 277 | 246 | 249 | 274 | 391 | 330 | 311 | 430 |
| 47 By water in coil | | No coil | | 843 | 995 | 988 | 815 | 335 | 575 | 554 | 414 |
| 48 Total absorbed | 9801 | 9994 | 9370 | 9990 | 9871 | 9947 | 9714 | 10086 | 9465 | 9270 | 9034 |
| **Heat Balance** (Per cent of heat in coal fired) | | | | | | | | | | | |
| *Heat absorbed* | | | | | | | | | | | |
| 49 By water in boiler | 79.4 | 81.6 | 75.6 | 73.4 | 70.8 | 71.5 | 72.4 | 76.8 | 74.0 | 73.0 | 72.7 |
| 50 By steam in superheater | 2.5 | 2.5 | 3.2 | 2.3 | 2.0 | 2.0 | 2.3 | 3.2 | 2.8 | 2.7 | 3.8 |
| 51 By water in coil | | No coil | | 7.0 | 8.2 | 8.1 | 6.9 | 2.7 | 5.0 | 4.8 | 3.7 |
| 52 Total and thermal efficiency | 81.9 | 84.1 | 78.8 | 82.7 | 81.0 | 81.6 | 81.6 | 82.7 | 81.8 | 80.5 | 80.2 |
| *Heat Carried Away* | | | | | | | | | | | |
| 53 By dry gases | 10.8 | 9.1 | 11.4 | 8.9 | 8.2 | 8.6 | 9.0 | 9.5 | 9.0 | 8.5 | 9.9 |
| 54 By steam from burning hydrogen | 4.1 | 4.3 | 4.2 | 4.1 | 4.1 | 4.2 | 4.2 | 4.0 | 4.2 | 4.1 | 4.2 |
| 55 By steam from moisture in coal | 0.1 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.8 | 0.9 | 0.9 |
| 56 By steam entering with air | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 57 By carbon monoxide | 0.0 | 0.0 | 1.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 58 By carbon in ash and flue dust | 0.6 | 0.6 | 0.7 | 0.4 | 1.0 | 0.7 | 0.8 | 0.4 | 0.3 | 0.3 | 0.3 |
| 59 By radiation | 2.5 | 2.6 | 1.9 | 2.2 | 2.3 | 2.1 | 2.3 | 2.4 | 2.4 | 2.5 | 2.2 |
| 60 Heat unaccounted for | —0.3 | —1.3 | 1.6 | 1.3 | 2.9 | 2.2 | 1.3 | 0.6 | 1.4 | 3.1 | 2.2 |
| 61 Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

[1] Cooling coil in operation during first $8^1/_2$ hours of test only.

B.t.u. were lost per sq. ft. of the exposed surface per hour when the boiler was operated at 100 per cent of rating, and 350 B.t.u. when operated at 200 per cent of rating. The radiation loss was calculated according to the percentage of rating developed. These calculations of the radiation loss leave the true "unaccounted for," which consists of errors. In a series of well-conducted boiler tests this true "unaccounted for" should be close to zero and should vary on both sides of the zero line according to whether the plus or minus errors predominate.

### Effect of Fineness on Results of Tests

It has been customary to state that in order to get good results the coal must be pulverized to a fineness of 95 per cent through a 100-mesh screen and 85 per cent through a 200-mesh screen. Table 2 gives the results of complete sizing tests of the coal burned in Tests Nos. 32 to 35, inclusive. The coal was much coarser than specified by the foregoing statement. The results of these tests seem to indicate that it is not necessary to pulverize the coal to the extreme fineness of 85 per cent through a 200-mesh screen in order to get good combustion and good efficiency. The completeness of combustion seems to be more a matter of a proper furnace and burner design and the right way of supplying air than of the fineness of the coal. The losses due to coarseness of coal would be shown by the greater percentage of carbon in the refuse. The average loss due to this cause for the four tests with the coarser coal is 0.7 per cent. The average of this loss for the previous four tests is 0.6 per cent. The averages of the efficiencies are very nearly the same.

TABLE 2 RESULTS OF SIZING TESTS OF COAL BURNED IN TESTS NOS. 32-35

| Test No. | —Percentage of Coal Passing Through Screens— | | | |
|---|---|---|---|---|
| | 20-mesh | 40-mesh | 100-mesh | 200-mesh |
| 32 | 99.9 | 99.2 | 93.2 | 67.6 |
| 33 | 99.9 | 99.2 | 93.1 | 70.1 |
| 34 | 100.0 | 98.9 | 90.8 | 65.5 |
| 35 | 99.8 | 98.0 | 88.6 | 64.0 |

The ability to burn coarser coal means increased capacity of the pulverizing mills, and decreased cost of coal preparation.

### Effect of Moisture in Coal on Results of Tests

Another statement that has been generally accepted is that coal must be dried to about 1 per cent moisture in order to be success-

(Continued on page 326)

# On the Organization of an Engineering Society

By MORRIS LLEWELLYN COOKE,[1] PHILADELPHIA, PA.

*The place which the engineer has come to occupy in our social economy suggests a reconsideration of a type of association and organization adopted at a time when the conception of the field of engineering was much more restricted than it is today. A gradual amplification of the definition of engineering and some regrouping of the divisions of engineering practice may be expected. While looking forward to a large and more or less immediate increase in the ranks of organized engineers, we need more than anything else an increase in the activity of the individual member. The structure of our present organization makes almost no provision for deciding in democratic fashion what is to be done and who is to do it. Bold and far-sighted administrative leadership in the execution of plans is difficult under the type of board or committee control which obtains in most societies of engineers.*

*To take advantage of present opportunities for public service, professional solidarity is the first requisite. But to wield wisely our rapidly accelerating power we need such democratic control of policies and such constant publicity as will permit larger individual initiative and even aggressive leadership in the execution of plans.*

BEFORE one can discuss intelligently the characteristics of the organization best adapted to an engineering society, the attempt must be made to reach some conclusion as to the essential nature of an engineering body and as to the scope of its functioning in the whole scheme of human society. Here again as in industry—and in life itself—before we can plan effectively we must know something as to the desired product, both as to its quantity and kind. We must know what is to be the relationship between organized engineering and other agencies through which the human spirit functions.

H. G. Wells tells us that even before "the coming of speech" there was the "fear of the old man of the tribe."[2] Here apparently is to be found the very beginning of our concepts of government, of sovereignty and of society. That we did not progress very rapidly in this matter of community organization is shown by the fact that some millions of years later we find Louis XIV proclaiming himself—and himself alone—to be the State. "*L'etat, c'est moi.*"

A good many people still look upon the Government—and the State—as something entirely apart from themselves, as residing largely in a single individual or at least within a very small coterie of those holding high office. Indeed, today's popular concept of sovereignty has not in many respects progressed much beyond that entertained by cave men.

But this doctrine is rapidly becoming too simple to command the confidence and loyalties of a race kept spellbound by the continuous revelations of science as to the interrelations of natural phenomena. Everywhere the nations are seeking an organization for society which shall be much more highly differentiated than that which obtained during the immemorial reign of force. We seek to distribute the function of leadership. In our own land every man is protected by statute in being a bit of a sovereign. The recognition of essential law, the spread of education, the elevation of mind over matter, and the philosophy of Christ make possible "preeminence by consent"[3] rather than by force. It is because of this new type of environment quite as much as on account of the ever-widening development of science and its application in the field of engineering that the engineer is being accorded a rapidly advancing status in modern civilization. Any one who has lived near to the brain and heart of our own Government—as some of our profession did during the war—knows that even in the face of grave danger the substance of unity is frequently missing in such ideas as sovereignty, government and the State. Of course one of the tenets on which our own nation was founded was the complete separation of Church and State. This action grew out of a clear recognition of one master division in sovereignty as it affects the lives of men. More recently we have seen the development of the organization of the labor movement in more than one nation to the point where tacitly or otherwise it exerts in some measure the prerogatives of sovereignty. Again, only the blind can fail to see the business groups in every nation exerting powers of sovereignty, sometimes through governmental channels and at other times entirely independent thereof. I have of course reference only to activities on the part of organized labor and organized capital which may be said, generally speaking, to have or to warrant the approval of organized society. Both groups of course at times seek to trespass, and as a matter of fact do err in trespassing beyond these bounds.

We should constantly have in mind that under present-day concepts the bases of national sovereignty lie ultimately in the wills of men. It is on this foundation that we Americans have reared the house of our national life with its various phases—industrial, social, professional, religious, etc. Threading its way through them all like the framework of a building in process of constant construction and reconstruction we find the Government coördinating—sometimes unifying—the life of the people. But never, let it be remembered, is government an end in itself.

In view of the foregoing, may we not altogether properly look forward to the day when the profession of engineering will be given that "preeminence by consent" which is more than an equivalent for sovereignty? It is altogether in the interest of society that we should prepare ourselves for such an "exercise of supreme authority" as will be consistent with the momentous content of engineering as it will be but a few years hence.

Competent observers outside the profession begin to sense the implications of our rapidly growing control of the bases of our common life. Thorsten Veblen refers to the profession as "the sufficient and indispensable general staff of the mechanical industries on whose unhindered teamwork depends the due working of the industrial system and therefore the material welfare of the civilized peoples."[1] Again, he says the industrial system "appears to be approaching a critical pass beyond which it will no longer be practicable...to entrust its continued adminstration to others than suitably trained technological experts." Equally suggestive of our rise to power are the titles of such recent books as Creative Chemistry[2] and The Conquering Engineer.[3]

The type of organization for an engineering society such as we seek is the one best adapted to make our group an effective cog in the whole scheme of social organization. No one engineering organization can seek its best development and largest future except as one link in the totality of the profession. It follows, then, as has been said on another occasion, that—

> Only through the solidarity—the essential oneness—of all the branches and divisions of the engineering profession will it be possible first to formulate and express an adequate sense of our public responsibilities and then to develop and use our collective initiative in their execution.[4]

We need an emphasis on the common characteristics of all good engineering in order to reveal the unity of the engineering approach. This once established we shall have what some one has called "mass morale"—an absolute essential for our highest professional development.

In the light of this definition of the function in human society of engineering and the engineer, our codes and definitions and standards of one kind and another take on a new importance. The dedication of the recently organized Federated American Engineering Societies exclusively "to the service of the community, state and nation" was indicative of a widespread feeling that the engineer can know but one allegiance when public and private interests are in conflict. Theoretically, this has been our pro-

[1] Consulting Engineer, Mem. Am. Soc. M. E.

[2] An Outline of History, H. G. Wells, p. 125.

[3] Studies in the Problem of Sovereignty, Harold J. Laski (Yale University Press), p. 19.

For presentation at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Bulletin of the Taylor Society, vol. iv, no. 4, August 1919.

[2] Creative Chemistry, E. E. Slosson (Dodd, Mead & Co.).

[3] The Conquering Engineer, Charles W. Baker (Dodd, Mead & Co.).

[4] The Inspiring Outlook before American Engineering, from the *Journal of the Engineers' Club of Philadelphia*, October 1920.

fessional attitude for some time past, as it has been of the doctor and the lawyer. But in the further step the Federation took with regard to publicity, service to the community as our objective becomes something more than a phrase. Under Article X of the Federation's Constitution it is provided that the "organization shall stand for the principle of publicity and open meetings," which through a by-law is interpreted to mean that "the privilege of attendance at all meetings of the American Engineering Council, of the Executive Board and of Committees, when not in executive session, shall be extended to any proper person;" also that "any proper person shall have the right to inspect and make true copies of the official records of all meetings of the Council, the Executive Board and Committees." By these stipulations the activities of the Federation are quite as open to view and review as those of the Government itself. This attitude is entirely in keeping with the profession's obvious destiny. Every engineering organization should adopt these practices, to the end that this attitude in favor of publicity and against secrecy become the hallmark of engineering. As a profession we cannot be too grateful to the sponsors of this fundamental change. Engineers now and in the future should jealously guard against any backward step in this matter. How better than through these provisions for publicity "shall we let the people know that we are building knowledge for their use, that we are serving every interest that they have and yet are slaves to none of them, that we will listen to every thought they bring and yet will weigh and value them with thoughts of other men in mind."[1] In fact, in the absence of studied and widespread and uncomprising publicity, such power as is undoubtedly coming to the technological group may become a menace. Unless we seek and obtain far-reaching public sanctions as we go along, something akin to a Frankenstein may result.

Consideration of the conditions under which engineering has more and more come to be recognized as a profession suggests that it will be increasingly difficult for the individual engineer to do his job except as he has a part in a highly differentiated professional engineering organization. This interdependence is well expressed by an English economist, R. H. Tawney:

> A profession may be defined most simply as a trade which is organized, incompletely, no doubt, but genuinely, for the performance of function. It is not simply a collection of individuals who get a living for themselves by the same kind of work. Nor is it merely a group which is organized exclusively for the economic protection of its members, though that is normally among its purposes. It is a body of men who carry on their work in accordance with rules designed to enforce certain standards both for the better protection of its members and for the better service of the public. The standards which it maintains may be high or low; all professions have some rules which protect the interests of the community and others which are an imposition on it. Its essence is that it assumes certain responsibilities for the competence of its members or the quality of its wares, and that it deliberately prohibits certain kinds of conduct on the ground that, though they may be profitable to the individual, they are calculated to bring into disrepute the organization to which he belongs. While some of its rules are trade-union regulations designed primarily to prevent the economic standards of the profession from being lowered by unscrupulous competition, others have as their main object to secure that no member of the profession shall have any but a purely professional interest in his work, by excluding the incentive of speculative profit.
>
> ....The rules themselves may sometimes appear to the layman arbitrary and ill conceived, but their object is clear. It is to impose on the profession itself the obligation of maintaining the quality of the service, and to prevent its common purpose being frustrated through the undue influence of the motive of pecuniary gain upon the necessities or cupidity of the individual.
>
> The difference between industry as it exists today and a profession is, then, simple and unmistakable. The essence of the former is that its only criterion is the financial return which it offers to its shareholders. The essence of the latter is that, though men enter it for the sake of livelihood, the measure of their success is the service which they perform, not the gains which they amass. They may, as in the case of a successful doctor, grow rich; but the meaning of their profession, both for themselves and for the public, is not that they make money but that they make health, or safety, or knowledge, or good government or good law. They depend on it for their income, but they do not consider that any conduct which increases their income is on that account good. And while a boot manufacturer who retires with half a million is counted to have achieved success, whether the boots which he made were of leather or brown paper, a civil servant who did the same would be impeached.[2]

Again, as an integral part of any discussion of engineering organizations should come a discussion of the organization of engineering itself. Its development had been so largely haphazard that the resulting fabric is not one that yields readily to logical organization. Indeed, our engineering front is very ragged. Here and there we find salients pushed so far out into the regions of the unknown as to constitute almost a menace to balanced progress—simply a useless diversion of energy and funds. Every one of us can think of phases of engineering upon which time and thought are devoted entirely out of proportion to the importance of the matter when considered as a part of the whole scheme of engineering progress. On the other hand, every one can suggest matters calling for investigation, coördination, and pure research, and for the lack of which whole sections of our engineering front are held back. I have specially in mind at the moment our own specialty of management. We know almost nothing about it except in an empirical sort of a way. And yet for the lack of such laws and data as would doubtless result from broad-visioned experimentation in administration and management, almost every undertaking of man is conducted under a heavy preventable loss. There are few studies in this field which insure an immediate or measurable financial reward, hence this master subdivision of engineering receives in a twelve-month probably not as much financial support as goes into researches on the incandescent lamp every day in the year.

One of the world's greatest authorities on organization, Wilhelm Ostwald, has discussed this unbalanced state of knowledge in connection with the sciences. It is almost word for word applicable to engineering:

> For what is organization? What is the meaning of this process that has proved to be of fundamental importance in all departments of our present social life? The word relates to the existence of the characteristic desired in living beings, in organisms, and it is among them, in fact, that we find the principles in question put into practice and their existence long recognized. We know that a living creature is all the more perfect in proportion to its having been able to develop proper organs for the varied functions peculiar to its existence, and in proportion to its assuring more completely the common and organized coöperation of these organs by means of a central nervous system. In connection with all organization there come into question two related yet distinct operations: on the one hand a division of functions and their apportionment to special organs for the purpose of having each single function all the more perfectly carried out by the particular organ formed for it; and secondly, a coördination of these single distributed functions in the interest of their common service in such a way that each single organ carries out its activities, in point of space as well as of time, so that it thereby produces the greatest gain for the whole organism. Therefore the distribution of functions and the combination of functions are the very essence of organization, and so we shall not be able to organize science otherwise than by separating its functions and then by reuniting them in collective efficiency.
>
> A suitable division of functions implies, moreover, a knowledge of the separate functions—i.e., it presupposes a general survey of the total range of the sciences, and demands therefore a system of them, and this is shown to be the great practical problem that must be solved if we are to organize scientific progress logically.
>
> One occasionally hears the objection raised that an organization of the sciences is not to be thought of, for the reason that science is the highest manifestation of spontaneous mental activity, and therefore is to be gratefully received, but should not be consciously and systematically directed toward definite problems and fields of work. Such an objection is not justified, for the reason that all human progress in all departments rests upon the fact that those things which have occurred heretofore unexpectedly and by chance are transformed into a systematized harvest in the field of human activity through our recognition of relationships established by law. Such an objection in the face of science has still less justification for the reason that science in its very essence rests, as we well know, upon the systematic, logical, and rational ordering of single facts.
>
> ....We are therefore confronted by the task of subjecting the whole range of science to the same organizing and systematizing process which has been carried out so successfully in single sciences, to the advantage of society as a whole.[1]

Before we organize new engineering societies or carry further the subdivision of existing ones into professional sections, we should put engineering through a systematizing process somewhat similar to that suggested for the sciences.

Perhaps of more immediate interest to us is the fact that organization is an attribute of life. We can group inert things as we do when we gather so many potatoes into a basket to make a bushel. But this is "aggregation, not organization." We management engineers should be the first to recognize that it is impossible to organize any but living entities. An engineering

[1] The Liberal College, Alexander Meiklejohn.

[2] The Acquisitive Society, R. H. Tawney (Harcourt, Brace & Howe), p. 92.

[1] The System of the Sciences, Wilhelm Ostwald, p. 110. (Rice Institute Pamphlet, Nov. 3, 1915.)

society in reality gets but little benefit from those who are "simply members." Their dues of course help. But one of the major tasks of all engineering organizations and societies is to get every member genuinely into some part of the play.

While it is an important task, it does not appear to be a difficult one. We are probably within the actual facts in assuming that not 50 per cent of the members of A.S.M.E. attend even one engineering meeting a year, and that less than 10 per cent of the 13,000 members indulge in any other form of organized engineering activity not directly associated with earning a livelihood. This condition exists largely because to remedy it never seems to have been set up as one of our problems. Possibly it has been assumed that to stagger along under the load of the inertia of the inactive 90 per cent is inherent in our proposition. In fact, I am not sure that we have not done many things which directly encourage this attitude of non-participation. The withholding of the vote from junior members apparently has had this effect. In fact, our whole attitude toward young men is one which holds them at arm's length and further seems quite out of harmony with modern thought. The world at large is coming to hold that progress is to some extent at least woven out of the thoughts of the less able members of the community—certainly that even the least conspicuous have an altogether vital contribution to make.[1]

Can we not look forward to the day when to be "simply a member" of any professional organization will be as exceptional as it is today to be "something more than a member?" One way to bring this about might be to have one section—possibly the Management Section—either make activity of some kind a test for membership or set up an active list on which would be carried only the names of real participants in section work. There are now so many different ways of coöperating to further the aims of an engineering society that every one can do something.

We have sought to see in the organization of an engineering society something far deeper and broader than the structure of its government—particularly because of the obvious application in this field of the adage, "The least governed are the best governed." Nevertheless administrative and managerial policies are of the essence of our task.

For some years past—particularly since the war—there has been a marked increase in the activities of all engineering organizations. For the most part this added activity has expressed itself in increase of membership campaigns, the multiplication of technical literature, and to a lesser extent in interest in public affairs. Practically no thought has been devoted to a study of the structure of the organizations through which we make ourselves felt. Engineering organizations are for the most part identical in type. This common scheme of association was designed at a time when there was no recognition of the field and function of the engineer as we understand it today. No material change has been made in the government of these societies except in the case of certain national associations which have slightly democratized their election machinery and more recently granted some measure of autonomy to local branches. This current type seems to err (1) in that there is little opportunity for a continuing and effective administrative direction and control, and (2) that there is almost no provision for the development of what might be termed the non-technical mind of the profession.

The constitution of every engineering society with which I am familiar not only places the administrative direction in the hands of a board, but makes no provision for a genuinely responsible administrative and managerial official. As I have elsewhere pointed out, the secretary of every engineers' association is by its constitution and by-laws subordinate to the board, not only in the sense that he is supposed to operate his office generally to the satisfaction of the board, but in the further sense that he is not supposed to inaugurate policies or to act in matters of any importance except in an effort to execute what has become the will of the board. In other words, the secretary of our typical society—nominally its manager—is not in reality a manager. Hence we have no one in the organization who in any way corresponds to the president of a company. I do not know that we should have. But I am sure that we have a very primitive and halting type of group direction and control through the board of directors. The weakness, in my opinion, does not grow so much out of the group control as out of the fact that the group gives very little time to the job. In the A.S.M.E. this is not more than thirty hours a year on the average.

[1] The New State, M. P. Follette (Longmans, Green & Co.), pp. 1–150.

The presidency as a rule goes to some distinguished member of the profession, and not always with regard to his capacity for administrative work. Even the best administrator would have little opportunity to accomplish results in the usual one-year term. Almost before the president knows what the problem is, his term of office expires. Usually our presidents are chosen in the midst of their professional success. They are busy men and cannot give all their time to the job. It would help if the president could be given duties somewhat comparable to those of the chairman of the board in private organizations. Such an arrangement would certainly meet the requirements for some years to come. If, however, the operations of engineering organizations grow as rapidly as now seems possible even for this post, effective service will mean more than a one-year term.

But the organization of the board and the functions assigned to a one-year president are relatively unimportant compared to the status given the secretary, executive secretary, or managing director who is charged with the administrative conduct of the society's affairs. If we are to attract to such posts and hold men capable of expressing the power and sweep and vision of present-day engineering, we need some *constitutional* delegation of responsibility to an official selected by the board, holding office at the pleasure of the board, and of course reporting to the board—but only in the sense that any president of a corporation reports to his board or that a city manager reports to the commission for the time being in office. The present arrangement, even when the secretary acts as if he had the authority, gives too much opportunity for avoiding responsibility in debatable matters. The present system too frequently results in the doing of the obvious, and in a more or less insipid and even halting administration. The board acts in a way as a buffer between the membership and the secretary. It has the power, but practically always refuses the responsibility which should go with it. The administrative official, even if fairly successful, is so in spite of the obvious handicaps.

The effort to reduce all engineering organizations to a single type is futile. Local initiative and even variation are to be encouraged, but as engineers, our obvious duty is to eliminate unnecessary overlap in field or function. Wherever economies can be effected by setting up joint agencies, this should be done.

In the matter of developing the non-technical mind of the profession and affording it adequate opportunities for more or less regularly recording its judgments, almost nothing has been done. In the absence of such a "mind" it is worse than futile to assume that any one can "speak" authoritatively for the profession. Now and again the effort is made to voice the engineering opinion of the nation, but it comes from such shallow waters that action is but little affected. But if we can organize to really sound out the depths of our professional thought, the judgments so rendered are certain to be woven into the very fabric of the future.

It has been said that "in respect of any undertaking, centralization, i.e., the administrative and management control recommended above, is the way to do it, but it is neither the correct method of deciding what to do nor the question of who is to do it."[1] Except as to the purely technical phases of engineering, there is practically no organized effort being made to decide what our engineering societies should be and do. In fact, it is only recently that a program for the profession has been recognized as a problem. It is quite unusual for an engineering society to afford an opportunity for the discussion of those society and professional affairs not directly related to specific engineering details. Every engineering organization should devote its best energies to developing a method whereby the task of the engineers as an organized group can be considered and outlined, and then kept constantly abreast the best thought of the profession and of the times. Either under the auspices of The Federated American

[1] Economic Democracy, C. H. Douglas.

(Continued on page 356)

## THE DESIGN OF LARGE LOCOMOTIVES

(*Continued from page 314*)

Blow-off cock handles should be so located that they can be operated by a man in position where he can see the water glass, and preferably without leaving his seat. The water glass, steam gage, air gages, etc., should be so located that they can be seen by the engineer when in usual position on his seat.

The throttle lever, power reverse lever, cylinder-cock lever, sander valves, brake valves, etc., should be located where the engineer can reach them handily when sitting in usual position on his seat or sitting with his head out of the window. It appears like a small detail, but it is a worth-while one to locate the straight air valve where it can be reached easily by an engineer when in such a position that he can see a man at the back of the tank giving signals for coupling to a train.

The lubricator must be at such a height that a man can see the feeds, and it must be high enough to avoid pockets in the oil pipes. It must be far enough below the cab roof to be filled easily.

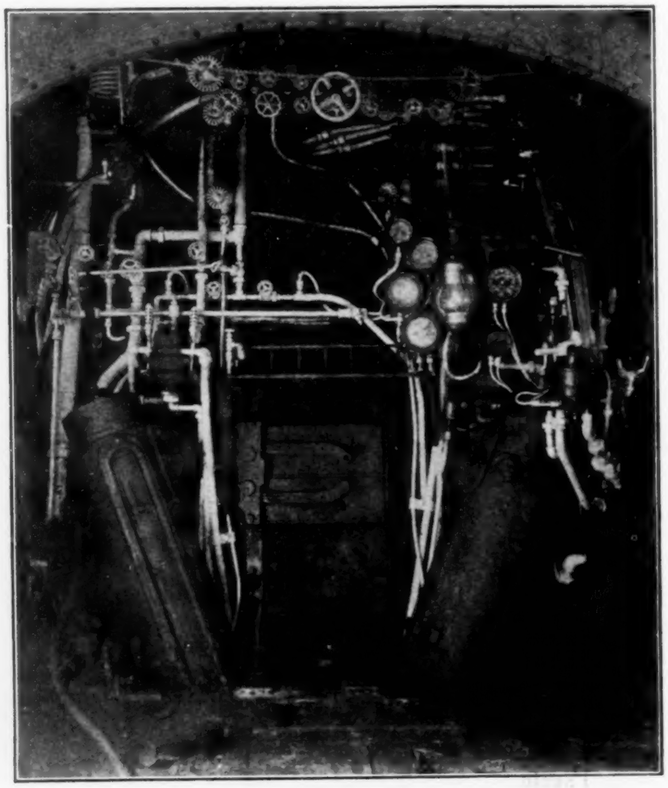


Fig. 6 Location of Boiler Back-Head Fixtures in Large Locomotive

Cab equipment requires careful study and it is difficult to locate the various appliances by drawing, but it has been done. A cab with a large amount of equipment on the boiler back head, yet which is regarded as being reasonably convenient, is shown in Fig. 6.

The use of clear-vision windows has made it somewhat difficult to arrange the seats so that either seat or window will be a height to suit different men. This problem, however, has been solved for one road by its motive-power department chief, who has developed an adjustable seat made of steel and having a spring cushion and an upholstered back. The back being secured to the seat and independent of the back of the cab prevents any vibrations resulting from shaking of the cab wall.

### Tender Capacity

Tender capacity should be arranged so as to reduce to a minimum the time a locomotive is detained from the productive work of hauling trains for the purpose of taking water and fuel. This implies large fuel and water capacities, but in arranging for suitable tender capacity care must be taken to avoid unnecessary weight, as any increase in the weight of the tender produces an equal decrease in the weight of train that can be hauled behind the tender.

Tender fuel space should be arranged so as to enable the locomotive to handle a full train with as few stops for fuel as may be feasible.

On territories equipped for water to be taken on the run or when stops for purposes other than taking fuel or water are made regularly at stations where water may be taken, the water capacity should be only sufficient to supply the locomotive when handling a full train, between water stations, with a moderate surplus for unusual delays.

On territories handling a large percentage of through trains with few stops, tenders of large capacity are desirable as they permit keeping locomotives more continuously at work. Where water is scarce and the supply has to be hauled to water tanks, tenders of large capacity are desirable as they reduce the number of water stations that must be maintained as well as the number of locomotives, cars, and men employed in hauling and handling water at these stations.

In addition to reducing time consumed by trains on the road, together with overtime pay to train and engine crews, large-capacity tenders effect a substantial saving by reducing the fuel consumed in starting and accelerating trains as well as the damage to locomotive machinery, draft rigging, tires and rail which frequently results from stopping and starting long freight trains. Train dispatching is simplified and the movements of superior and opposing trains are expedited, as a train which keeps moving interferes less with the movements of other trains than one which must stop frequently, thereby introducing uncertainty as to how long it will be detained.

## BOILER TESTS WITH PULVERIZED COAL

(*Continued from page 322*)

fully burned in pulverized form. In order to determine to what extent this statement is true, tests Nos. 36, 37 and 38 were run with undried coal. The results of the tests show that the completeness of combustion was as good as with the dried coal. There was no loss due to CO in the flue gases and the losses due to combustible in the refuse averaged only 0.3 per cent for the three tests, which is in fact less than the average with the dried coal.

The losses due to moisture in coal of course increased 0.5 to 0.6 per cent, which increase is at the rate of about 0.1 per cent for every 1 per cent of increase of moisture in the coal. The average decrease in the boiler efficiency for the three tests is about 0.7 per cent, which checks closely the increase in the losses due to increased moisture in the coal. It seems, therefore, that it is not necessary to dry the coal down to 1 per cent of moisture in order to get good boiler efficiency. In fact, it seems that most of the eastern coals can be pulverized and burned with good results without drying.

### Capacity of Boiler That Can Be Developed with Pulverized Coal

The capacity of boiler that can be developed with pulverized coal depends entirely upon the size and shape of the furnace. With the present knowledge of the art of burning powdered coal the best results are obtained when the coal is burned at the rate of 1 to $1^1/_2$ lb. per cu. ft. of combustion space per hour. Good results can be obtained when the coal is burned at rates varying from $^1/_2$ to 2 lb. per cu. ft. of combustion space per hour, which gives a considerable working range. In Table 1 the rate of combustion is given by item 12. The range covered by this series of tests is from 1.05 to 1.81 lb. of coal per cu. ft. of combustion space. If it is desired to operate the boiler at high rates of working, a large furnace must be installed, and the combustion space must be so arranged that the flames are given the longest possible path through the furnace. The design of burners and the admission of air are very important at high rates of combustion. It appears probable that future developments in the design of furnaces, burners and the air supply may make possible higher rates of combustion than the limit given above.

# SURVEY OF ENGINEERING PROGRESS

**A Review of Attainment in Mechanical Engineering and Related Fields**

## Losses in Convergent Nozzles

THE paper here abstracted, by Prof. A. L. Mellanby and Wm. Kerr, deals in particular with the anomaly of the velocity coefficients and especially with the falling off in the standard of performance of convergent-type nozzles with restriction of the range of expansion.

This fact has been thoroughly demonstrated by experiment and may be shown in the form of a curve representing the variation of the coefficient of velocity or of discharge with change of pressure ratio. This curve always shows continuous reduction of the coefficient of discharge with limitation of the range, thus apparently indicating higher proportionate energy losses for the lower fluid speeds, as, for example, in Fig. 1.

Curve 4, which is derived by Professor Gibson from experiments on an air venturi meter, demonstrates that this effect is common to the expansion of different fluids. Although the venturi form is apparently convergent-divergent, it is operating only as a convergent type within the expansion ranges to which the discussion applies, and from which the coefficients were obtained.

Fig. 1 shows coefficients of discharge. The velocity coefficients are directly comparable with these, but in general are slightly higher. The nozzle efficiency may be taken as given by the square of the coefficient of velocity; and, since the higher ratios show the lower coefficients and correspond to the lower speeds of flow, the efficiency is apparently poorer with the less rapid motion.

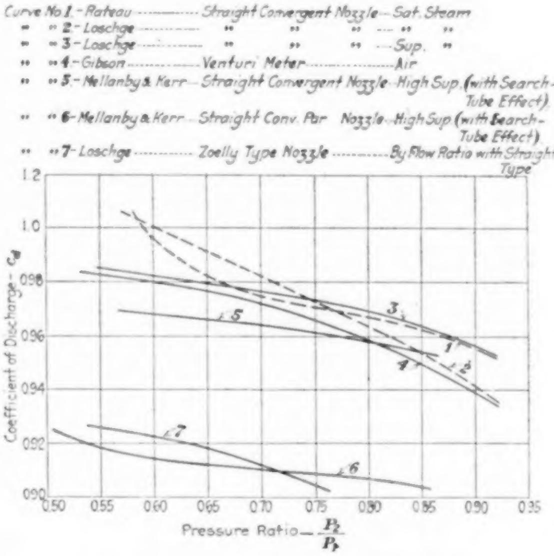



FIG. 1 VARIOUS DISCHARGE COEFFICIENTS

Such a result is contrary to any preconceived ideas of the matter, as it would seem only natural to expect the best efficiencies at the lowest speeds. The anomaly so presented has been frequently remarked upon, and has created a feeling of perplexity that shows itself in the widely varied explanations that have at times been advanced.

The various hypotheses that would account for the vagaries of nozzle flow are presented and discussed by the author.

One hypothesis which they offer is that the non-uniform distribution of velocity across a section of nozzle might be conceived as independent of pressure variation, which might be considered due to boundary and viscosity effects and is actually known to exist in slower pipe flow. This is examined mathematically and at first glance appears to give an adequate solution, but does not, as the authors explain further.

To give a real explanation of the behavior indicated by the curves in Fig. 1, the authors endeavor to examine the causes underlying the growth of loss along the expansion.

The ordinary idea of nozzle loss is that it is mainly due to friction effects that increase rapidly with the speed. The authors, however, proceed to prove that $e$, which is the total energy loss per second in the nozzle, is not a purely frictional loss, and while such a loss may be involved in it, it is accompanied by another effect either of constant magnitude or increasing only with the low power of the speed, but sufficiently important to counteract definitely the natural influence of the normal frictional loss.

If two such loss effects exist and can—even imperfectly—be separated, it would be of interest to secure data as to the order of frictional resistance at high velocity speeds, and also whether these are at those speeds proportional to the square of the speed as they are at moderate speeds.

As regards the convergent nozzle, which is, by the way, the type most generally used in modern practice, there is direct experimental evidence that a velocity of efflux closely agreeing with that of sound presents the best condition, and the authors ask whether this is due to some particular virtue in this high speed, and whether this characteristic fact applies to the action on the blading or is peculiar to the nozzle alone.

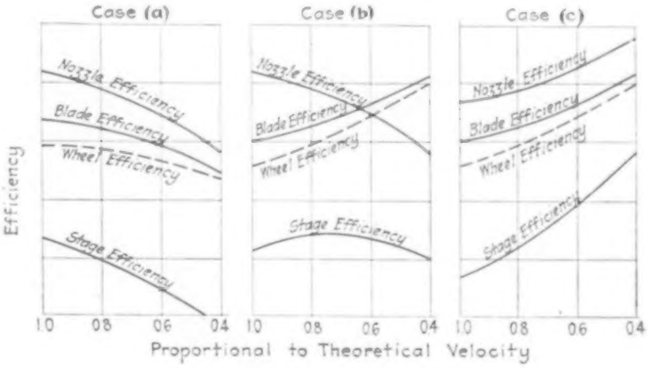



FIG. 2 EFFICIENCY-CURVE FORMS

Is it in brief the effect of the speed or something peculiar to the expansion? Fig. 2 shows three possible combinations of rational curve forms that could be used as a result of more or less accurate deductions from test figures, where nozzle and blade effects cannot be definitely separated. The wheel-efficiency curves represent a change of form due to the necessary consideration of mechanical losses. As regards the stage-efficiency curves, case ($a$) requires the highest speed, case ($b$) a figure somewhat lower, and case ($c$) very moderate values indeed.

All turbine designs may be classified under one of these cases. Case ($a$) depends for its development on the availability of better materials that would make possible the use of higher blade speeds; case ($b$) comprises designs based on the assumption that practically the best conditions have already been reached, while the designs of case ($c$) rely for the attainment of the ends on the multiplication of stages. Marine impulse turbines belong to this class, which may be partly due to the influence of some such conditions as are embodied in case ($c$), but also to the somewhat lower blade speed supposed allowable in marine applications.

The experimental method used by the authors consists simply in passing a search tube along the axis of the expanding jet, in conjunction with which accurate measurement of the mass flow is made. These observations are carried out on any given nozzle under fixed initial conditions of supply, which are so arranged that the expansion is confined to the superheat field.

The reheating effect on the fluid due to the losses in the expansion is determined from the equation—

$$0.718\left(\frac{V_1}{P_1}\right)^{1/2}\frac{G}{A} = \frac{r\left(1-k-r^{\frac{n-1}{n}}\right)^{1/2}}{k+r^{\frac{n-1}{n}}} \qquad [1]$$

in which $P_1$ = pressure of supply, lb. per sq. in.
$V_1$ = specific volume, cu. ft. per lb.
$G$ = mass flow, lb. per sec.
$A$ = flow area, sq. in.
$r = P/P_1$ = pressure ratio at any point where pressure is $P$
$k$ = reheating or loss factor
$n$ = index of the law ($PV^n$ = constant) for the reversible adiabatic in the field of expansion
= 1.3 for superheated steam.

Here $k$ depends on $A$, which in certain cases may be measured and in other cases determined otherwise.

Either side of Equation [1] expresses the value of what has been termed the jet function, since certain important quantities that outline the jet conditions are embodied therein. Which side is used in any particular instance depends upon which variable is being considered. Thus to write the jet function $F$ as—

$$F = 0.718\left(\frac{V_1}{P_1}\right)^{1/2}\frac{G}{A} \qquad [2]$$

provides a form in which the flow area of the jet is the essential variable, and it is seen that this is simply inversely proportional to $F$. If the function is written—

$$F = r\frac{\left(1-k-r^{\frac{n-1}{n}}\right)^{1/2}}{k+r^{\frac{n-1}{n}}} \qquad [3]$$

a form is obtained in which the loss factor is the important quantity considered. The relationship between $k$ and $F$ is not very direct, but, with $F$ and $r$ known, $k$ can always be computed.

Again, it is easy to show that—

$$\left(1-k-r^{\frac{n-1}{n}}\right)$$

is proportional to the kinetic energy of the jet; while—

$$\left(1-k-r^{\frac{n-1}{n}}\right)^{1/2}$$

is similarly proportional to the velocity. Also the factor—

$$\left(\frac{k+r^{\frac{n-1}{n}}}{r}\right)$$

is in direct proportion with the specific volume of the fluid. These meanings for the detail factors are rather useful, and besides the fundamental importance of Equation [1], it is probably advisable to emphasize the following:

If volume factor $= \dfrac{k+r^{\frac{n-1}{n}}}{r} = m$

then

Jet flow area varies as $\dfrac{1}{F}$

Actual jet energy varies as $(Fm)^2$

Actual flow velocity varies as $(Fm)$.

The absolute results of the various quantities so represented by mere ratios can be readily obtained at any time, since all are referable to the initial conditions, thus:

$$\text{Energy (ft-lb. per lb.)} = \left(\frac{144n}{n-1}\right)P_1V_1\left(1-k-r^{\frac{n-1}{n}}\right)$$

$$\text{Velocity (ft. per sec.)} = \left\{\left(\frac{288gn}{n-1}\right)P_1V_1\right\}^{1/2}\left(1-k-r^{\frac{n-1}{n}}\right)^{1/2}$$

$$\text{Specific volume} = V_1\left(\frac{k+r^{\frac{n-1}{n}}}{r}\right)$$

From the forms of these it follows that the loss of energy per lb. is—

$$\frac{144n}{n-1}P_1V_1k$$

and this energy being dissipated in heat causes the specific volume to be

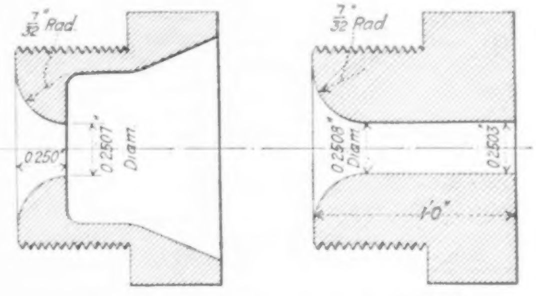
$$\frac{V_1}{r}k$$

in excess of what it would be theoretically.

These considerations show that if by experiment or otherwise the jet function is established for any point on the jet by means of relation (2) then, by means of experimental values of $r$ and Equation [3], it becomes possible to determine the velocity and volume conditions at the point considered, and the total expansion loss that has accrued up to that point.

Strictly speaking, $k$ is a reheating effect rather than a loss effect, but under the conditions of single-nozzle testing the difference between these is entirely negligible and need not be considered. Consequently the terms reheat and loss are used indiscriminately in specifying the quantity that $k$ represents.

In addition to this, the authors show how various coefficients employed in nozzle work may be obtained from the general ex-




Nozzle "a" Nozzle "b"

FIG. 3 CONVERGENT-NOZZLE FORMS

pression. This applies in particular to the coefficient of discharge and coefficient of velocity.

In the actual tests two convergent nozzles were used and the main tests were carried on with initial pressure of 75 lb. per sq. in. abs. and initial temperature of 560 deg. fahr. (An initial temperature of 400 deg. fahr. was also used in some tests, but the difference in the results for the two conditions proved to be very small.)

The two nozzles are shown in Fig. 3. Table 1 gives the various

TABLE 1 DATA ON TESTS OF TWO FORMS OF CONVERGENT NOZZLES

| Nozzle | Initial pressure, lb. per sq. in. (abs.) | Initial temperature, deg. fahr. | Steam flow, lb. | Duration of test, sec. | Nozzle pressure ratio[1] | Values of $F$ at throat | Values of $F$ at outlet |
|---|---|---|---|---|---|---|---|
| Simple Convergent Nozzle (a) | 76.0 | 559 | 46 | 1301 | 0.580 | .... | 0.2193 |
| | 76.0 | 565 | 46 | 1304 | 0.574 | .... | 0.2195 |
| | 76.0 | 568 | 46 | 1314 | 0.593 | .... | 0.2181 |
| | 76.0 | 569 | 43 | 1311 | 0.710 | .... | 0.2044 |
| | 76.0 | 567 | 35 | 1321 | 0.834 | .... | 0.1650 |
| Convergent Parallel Nozzle (b) | 76.4 | 558 | 59 | 1742 | 0.498 | 0.2088 | 0.2100 |
| | 76.4 | 566 | 49 | 1460 | 0.495 | 0.2077 | 0.2088 |
| | 76.4 | 565 | 45 | 1355 | 0.582 | 0.2055 | 0.2066 |
| | 76.4 | 565 | 40 | 1301 | 0.717 | 0.1903 | 0.1914 |
| | 76.4 | 567 | 33 | 1349 | 0.852 | 0.1515 | 0.1524 |

[1] Outlet pressure divided by initial pressure.

data; the function values included are for definite flow areas only, that is, for plane cross-sections in the parallel regions. The definite sets of figures in each case are obtained by variation of the back pressure, and the flow and function values are therefore obtained in terms of the pressure ratio of operation of the nozzle.

In conjunction with these, fall-of-pressure curves have been obtained for each condition. The expansion curves are very smooth lines and no material pressure fluctuations within the

nozzle length were found, which is characteristic of convergent nozzles.

If the function values at the outlet section are plotted against the nozzle pressure ratios, both as given in Table 1, the curves termed "flow curves" in Fig. 4 are obtained. This figure also includes a theoretical curve for $F$, which represents the value the function should have had for any specified ratio if expansion took place without loss.

The authors point out that the experimental points in Fig. 4 lie on quite a smooth curve. They also find it is allowable to omit from further consideration the two and three sets in each case, and that in order to cover the full range of action dealt with experimentally, it is sufficient to consider only the case represented by the points marked (*i*), (*ii*) and (*iii*) on each flow curve.

The three different outlet conditions for each nozzle may now be assumed as being completely established, and the probable internal conditions for any and all of these cases may be considered. This, however, is not quite as simple as it looks.

Thus, if we consider nozzle *a*, the problem takes the form of a determination of the $F$ curves which represent the internal conditions along the jet. Again, Equation [2] gives $F$ as a function of $A$, and if $A$ could be calculated at various points from the nozzle sectional areas the problem would be simple. The authors show, however, that this cannot be done, because where the temperature is changing rapidly the pressure is not uniform over a plane cross-section and the area for any given pressure is not the same. The best way to obtain the correct forms of the $F$ curves is by trial and error, using a rather complicated equation which the author gives as a check. It was in this way that the three curves shown in Fig. 4 for nozzle *a* were obtained. These curves are not continued beyond a ratio of 0.9. They seem, however, to be converging together and are very close to the theoretical. The above method of derivation is not employed to carry the curves further, because the method ceases to be at all sensitive when transition is made from the steep portions of the pressure-ratio curves to the flat top parts.

As regards the convergent parallel nozzle *b*, it is found that when throat values are plotted each practically lies on the corresponding $F$ curve of nozzle *a*, which would tend to confirm the correctness of these curves.

On the whole, the $F$ curve in Fig. 4 may be used for the purpose of determining the forms of the loss curves throughout the various expansion ranges, but in passing from the $F$ values to the loss which these values denote, it becomes necessary to bear in mind that the resultant figures are affected by experimental errors. While these errors are small in so far as their effect on the $F$ values is concerned, this is not so in reference to the difference between theoretical and actual $F$ figures, and it is on these differences that the losses depend.

The losses for different $r$ values can be determined from the $F$ curves of Fig. 4 by means of Equation [3], and the work may be facilitated by employing calculating charts based on that equation.

The authors discuss in detail the subject of the boundary loss and the convergent loss and come to the following general conclusions:

**The losses in a nozzle are referred to by a factor $k$ which, in continued product with the initial pressure and volume conditions, gives the energy loss per pound. If this factor is strictly constant for any given ratio of expansion, independent of supply conditions, then the flow per square inch of area is accurately proportional to:**

$$\left(\frac{P_1}{V_1}\right)^{\frac{1}{2}}$$

**Any dependence of $k$ on $P_1$ and $V_1$ upsets this proportionality, but the discrepancy will be the smaller if only a portion of the total $k$ is thus affected. General experimental work shows that mass flow is closely proportional to the above factor, but not exactly so, the disagreement being of much the same order as experimental error.**

**It has been shown that in the expansion of a fluid through a nozzle there are at least two distinct types of loss. One, an effect of friction, seems demonstrated with fair conclusiveness; the other is apparently an inherent feature of the convergent portion of the expansion.**

The frictional effect, termed the boundary loss, is due to the sweeping of the confining surfaces by the high-speed fluid. The frictional drag thereby established shows its characteristic dependence on the square of the speed even up to such a high figure as the speed of sound. The loss factor $k$ in this case appears to be entirely independent of the initial conditions, and is given by integration along the axis, the integrand being a function of the hydraulic mean depth and of a speed factor that varies only with the ratio of expansion. The constant involved will, of course, cover the influence of the surface finish.

This boundary loss may conveniently be considered as due to a scattering of flowing molecules resulting from impingement on the irregularities of the surface, with consequent retransformation of their flow motion into heat motion.

The second type, called the convergence loss, is caused by the rapid convergence in the entrance. It is shown that this effect is too great to arise from the work done against the deformative stresses created by viscous action; and it is indicated that the cause probably lies in effectual mass motions within the streaming body of fluid. The loss factor is shown to be largely dependent

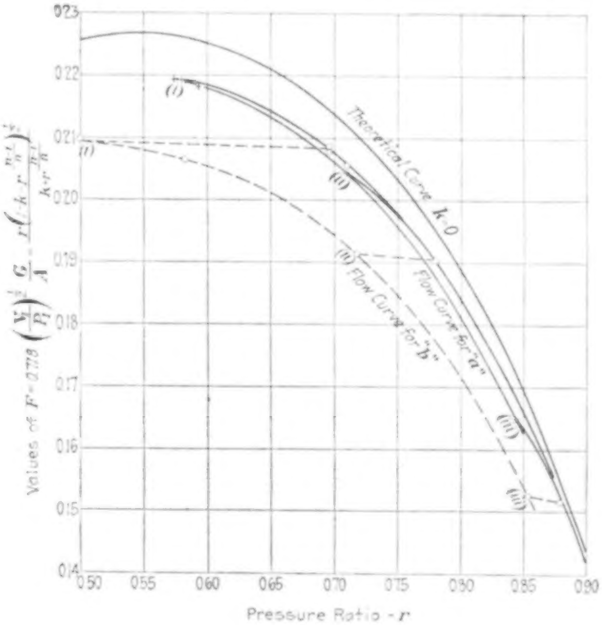



FIG. 4 $F$ CURVES

on the velocity developed in the convergent portion of the jet, but it must also be influenced by the actual nozzle form; and therefore any expression given the loss must contain some function of the convergence. Since with a fixed convergence the velocity is primarily important, the loss is affected by initial conditions of supply, and therefore departure from the practial rule that flow is proportional to the square root of $P_1/V_1$ must be expected. This departure will be the greater in those cases where this particular loss is a large proportion of the whole, e.g., in the purely convergent types, and this is in rough agreement with the experimental evidence available.

This convergence loss is then attributable to the establishment of molar currents in the main stream by and in the convergence. The damping out of these as the jet narrows to a straight path would cause a reheating effect by retransformation of kinetic energy.

**It will be seen that the separation of frictional and convergence effects gives at once, through their different natures, a definite reason why the nozzle coefficients should fall as the expansion range is narrowed. The latter effect, measured per pound, is not reduced so rapidly as the available energy, and therefore has an increasingly important influence as the pressure ratio of action rises.**

**The rate of fall of the coefficient, whether of discharge or velocity, will depend on the relative magnitudes of the two losses. With any convergent type having a fixed inlet form the fall should be**

less rapid as the straight tail length is increased, owing to the ready manner in which the frictional effects acquire a dominant influence. With nozzles of equal tail length, however, the more objectionable convergence will cause the more rapid fall. Thus, considering the convergent types used in actual turbine work, the forms at inlet are such as would compel belief that their convergence loss is more severe than that of the simple circular straight types, since there is rectangular formation, curvature of axis, and distinct differences in curvature between the two pairs of opposite sides. In this connection it is significant that the very scanty data obtainable on practical nozzles confirm this finding, the curves derived by Christlein, for instance, having an extremely rapid fall.

Again, the size of the nozzle would presumably have an influence on this loss, as the disturbing currents might then be supposed to be more extensive. If so, the slope downward of the coefficient curves would be more noticeable for the larger nozzles. There are practically no large-scale steam experiments, but reference to Fig. 1 will show that Professor Gibson's curve for air displays this feature. Now these experiments were made with diameters of the order of $1^1/_2$ in., that is, several times the size of experimental steam nozzles, and it would therefore seem that there is a definite dimensional influence.

The effect of dimensions on the convergence loss will be opposite to that on the boundary loss. It must be clearly in view that the frictional occurrences are apparently inversely dependent on the hydraulic mean depth, and therefore small-scale experiments are most suitable for the examination of these. Thus, in the authors' experiments the introduction of an $^1/_8$-in. diameter search tube into a $^1/_4$-in. bore nozzle increases the surface by 50 per cent and reduces the flow by 25 per cent, i. e., the search tube doubles the effect and therefore makes it the more readily determinate. For the same reason efficiencies obtained from such small nozzles are not directly applicable to larger sizes, and therefore to say that the experiments are faulty because in practice better values are apparently shown, is no sound charge. Application to the practical forms can only rationally be made when the constant factors in the different loss effects are known.

It may be taken, then, that the total loss to any point $x$ along the jet within the boundary form is given by—

$$k_t = a_1 \int_0^x (Fm)^2 \frac{l}{A}\, dx + a_2(P_1V_1)^{1/2} \int_0^x \left\{ f(c, x) \frac{d}{dx} (Fm) \right\} dx \quad [26]$$

This expression is too involved to be of much practical value, but considerable simplification is possible with only moderate loss of accuracy. It may be permitted to charge the frictional loss against the tail piece only, and relate this to the average velocity factor therein; while the entrance loss may be made directly dependent on the speed established in the convergence, thus:

$$k = a \times \frac{L}{h} (Fm)_0^2 + b(P_1V_1)^{1/2} (Fm)_c \quad [27]$$

where $a$ = constant for surface
$L$ = length of parallel portion
$h$ = hydraulic mean depth of parallel portion
$(Fm)_c$ = velocity factor at end of convergence.

Although $(Fm)$ contains $k$ as a term, the influence of this is not great and $(Fm)$ might be taken as equal to the theoretical—

$$\left(1 - r^{\frac{n-1}{n}}\right)^{1/2}$$

Actually, however, it will be found that by using a suitable chart for calculation rather closer approximations to the real values can be obtained.

Taking the actual nozzles used, the constants are of the following order: $a = 0.0055$; $b = 0.0005$. The constant $a$ is for a moderately well-finished bored-out brass nozzle, while $b$ covers the convergence effect for a small nozzle having a straight axis and a radius of entry nearly equal to the diameter.

For practical application further experimental investigations seem necessary, and a few final remarks on the best forms for these might be given.

The boundary loss will be most readily obtained from examination of the action in straight parallel lengths. The value of the jet function $F$ is constant along such a path, and the growth of loss is closely represented by a straight line. For these reasons pressure readings are only necessary at entrance to and outlet from the parallel portion. Again, this frictional loss is most clearly shown by flow experiments on small-size nozzles.

Consequently for the determination of frictional constants a few long parallel nozzles—of small bore and having different surfaces—might be used; provision also being made for the observation of at least two pressure values.

Examination of the convergence loss requires determination of the conditions in a clearly defined area at the termination of the entry curve. Any chosen convergence must then be fitted with a very short parallel outlet; although with the more awkward form rather greater lengths might be necessary to insure fairly stabilized conditions. There are effects both of curvature and size, and it is probable that experiments with air flow might give a more ready means of examination.

For the convergence effects, then, a few standardized entrance forms might be used—each with short parallel outlet—each form, say, in triplicate, differing only in linear dimensions. Mass-flow determination accompanying pressure reading at outlet would then allow of establishment of the general variation of this loss, and any odd form that might be used at times in practice could be reasonably covered by interpolation from the known standard results. (Paper before the *Northeast Coast Institution of Engineers and Shipbuilders*, Feb. 18, 1921, 40 pp., 22 figs., *etA*. Abstracted from advance proof.)

# Short Abstracts of the Month

## AERONAUTICS (See Power Plants and Varia)

## AIR MACHINERY

### Pressure Regulation in Air Receiver or Line—Operating Air Compressors in Parallel

The Automatic Regulation of Air Compressors, Robert Nitzschmann. In compressor operation it is usually necessary to maintain a constant air pressure. In some cases, particularly with small and medium-size units, hand regulation is employed for governing the delivery air pressure either by varying the amount

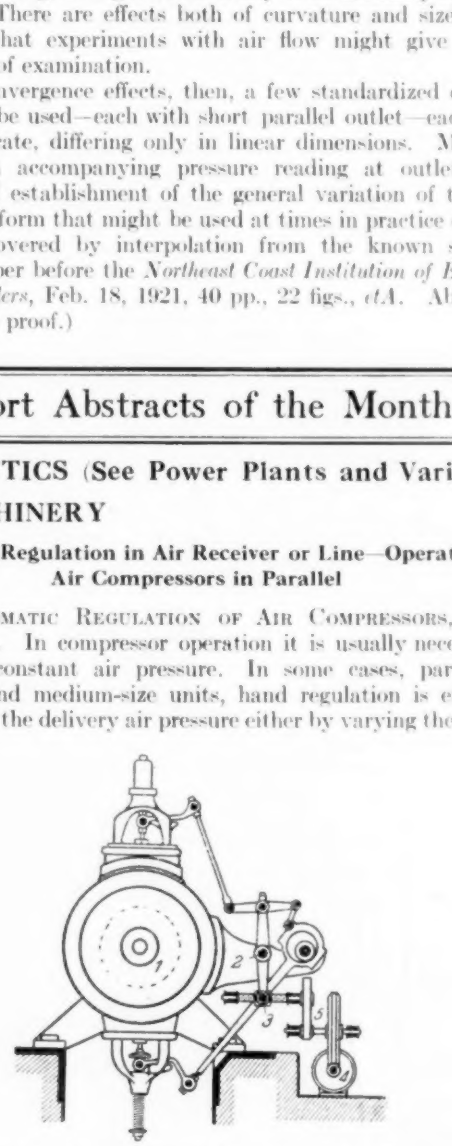


Fig. 1 Device for Automatically Regulating Air Pressure of an Air Compressor

of inlet air (throttling regulation) or by operating directly on the steam supply to the driving prime mover. For larger installations automatic regulation is necessary, which again may be of two kinds: namely, operating by the air pressure directly, or through some kind of a servo-motor.

In the present article a device is described which makes it possible to regulate the air-compressor output not only from the pressure at the compressor directly but also in accordance with the pressure with air lines fed by the compressor.

Fig. 1 shows the governing device as applied to a steam-driven air compressor. Here, 1 is the steam cylinder; 2, the valve-gear shaft; 3, the lever of the valve-gear shaft with the crosshead;

4, an electric motor; and 5, an intermediary element between the electric motor 4 and the lever 3.

The operation of the device is as follows: When the air pressure in the receiver varies, an appropriate relay (Fig. 2) sets the motor 4 in motion in such a way that, for example, the motor 4 rotates the shaft 2 of the valve gear governing the steam admission to cylinder so that the admission decreases, which results in a corresponding decrease in the speed of operation of the compressor. This variation of admission lasts until the desired pressure is reestablished in the receiver. In the case of falling off of pressure in the receiver, a similar operation takes place but in the reverse sense.

Fig. 2 shows the arrangement of the pressure relay employed with a polyphase servo-motor. According to the position occupied by piston 1 of the relay, the contact arms 2, 3 and 4 press against either the contacts 5, 6 and 7(pressure too high and the motor

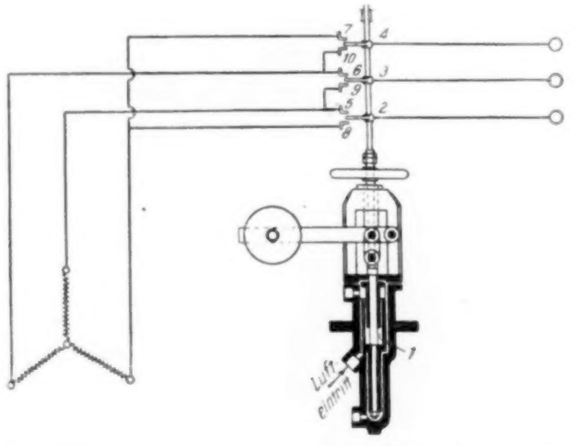


Fig. 2 Electrical Relay Employed with the Device Shown in Fig. 1
(*Lufteintritt* = Air Inlet)

decreases admission of steam to the steam cylinder) or contacts 8, 9 and 10 (pressure too low in the receiver and more steam is caused to flow into the steam cylinder).

Where an extensive system of piping and machinery has to be supplied with compressed air, especially from several air compressors located at different points, it is often important that a certain predetermined amount of air be supplied at a constant

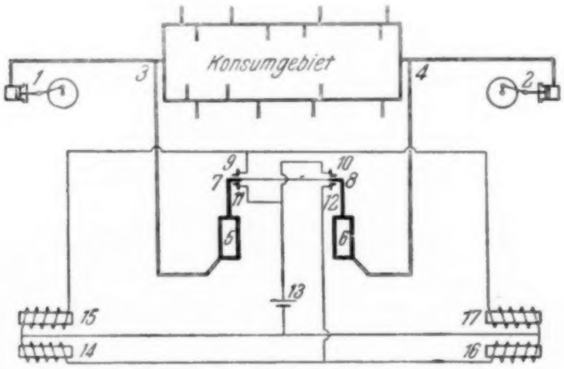



Fig. 3 Device Shown in Figs. 1 and 2 Applied to a System Employing two or More Compressors
(*Konsumgebiet* = Piping and Machinery Fed from the Compressors)

pressure. Fig. 3 shows the connections to the regulating motors to cover such a case.

In this figure 1 and 2 are two air compressors located at different points; 3 and 4 are the points at both ends of the system supplied by compressed air at which the given pressure is maintained; 5 and 6 are the pressure relays belonging respectively to 3 and 4 with pistons carrying the electric contact arms 7 and 8; 9, 10, 11 and 12 are respectively the stationary contacts of the pressure relays; 13 is a source of electric current; and finally 14, 15, 16 and 17 are the electric relays operating the servo-motors located respectively at each of the compressors 1 and 2 and governing the admission of steam to the steam cylinders in the manner described.

With this system of governing, the operation is as follows: If, for example, at the point 3 of the piping system fed by the compressors, the air pressure becomes excessive, the movable contact 7 is forced against the stationary contact 9. The two motors 1 and 2 at the compressors remain idle and the equalization of pressure takes place right in the piping system without calling on the automatic regulation. It is only when the pressure at 4 also exceeds the desired limit that the circuit is closed, the electric relays 15 and 17 are energized, and the steam supplied to the engines driving the compressors 1 and 2 is simultaneously reduced. The regulation is similar when the air pressure in the line falls below the desired limit.

With appropriate variations the same method of regulation may be applied to rotary compressors and may be used to govern the compressor output instead of the receiver pressure. (*Feuerungstechnik*, vol. 9, no. 9, Feb. 1, 1921, pp. 74–75, 3 figs., *d*)

## FUELS AND FIRING

### What Determines the Clinkering Ability of Ash?

Constituents in Ash that Cause It to Fuse, G. A. DeGraaf. The discussion applies in particular to bituminous coal. Among other things, the author shows that sulphur in bituminous coal occurs mainly in the form of iron pyrites, which, when burned

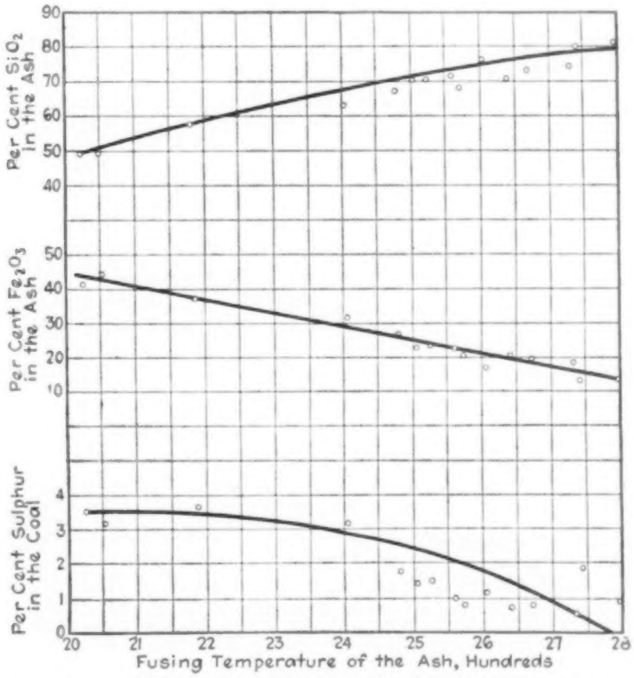



Fig. 4 Curves Showing Relation of Fusing Temperature of Ash to Percentage Content of Silica, Iron Oxide and Sulphur

with the coal in the fuel bed, forms iron oxide, a material which by itself would not produce clinkers. If, however, this iron oxide is exposed to high temperatures in the presence of silica and silicates usually also available in the ash, clinker in the form of fusible silicates may be produced.

It is temperature of the grate and of the fuel bed near the grate that determines whether a certain coal will form troublesome clinker or no clinker at all. Because of this, it is important to keep the grate and the part of the ash bed near it at as low a temperature as possible during operation.

On the other hand, however, if coal contains pyrites in large lumps they may fuse before they are completely burned and start the formation of clinkers. The conclusion to which the author comes is, therefore, that although high sulphur content may increase the possibility of clinker formation, it is not a definite indication that clinkers will be produced, as the action depends upon the form in which the sulphur is present.

The author calls attention to the fact that the complexity of the content of the ash makes it difficult to draw a conclusion as to its tendency to form clinker. Fusibility of ash depends apparently upon the ratio of the silica to the iron, aluminum, calcium, etc., present. As a rule, ash high in silica contains little iron and will not fuse easily, but if the silica decreases and the iron increases, fusing will take place at a lower temperature. The author does not believe that a definite relation between the clinkering properties of coal and the chemical composition of well-mixed ash can be found, especially as in addition to the chemical analysis there are many other factors which influence clinkering, such as the construction of the furnace, combustion space, draft, cooling of the grates, etc., as well as the methods of firing.

Fig. 4 is of interest as giving an idea of the relation of fusing temperature of ash to the percentages of silica, iron oxide and sulphur.

The author explains the methods of carrying out fusibility tests of ash and in particular the use of Seger cones. (*Coal Age*, vol. 19, no. 12, pp. 534–539, 5 figs., *pe*)

## LUBRICATION (See also Power Plants)

### Tests on Lubrication with Emulsified Oils

Lubrication of Steam Cylinders with Oil Emulsions, Dr. Eng. Hilliger. Data of tests bearing on performance and consumption of lubricant by steam engines lubricated with plain oil and oil emulsions, carried out at the Salbke Works of the R. Wolf Company, Magdeburg, Germany, on a 25-hp. non-condensing locomobile engine.

In the course of these tests either plain oil or an emulsion of oil with saturated lime water was used, the lime water having a content of 1.2 grams (18.4 grains) of lime per liter (0.26 gal.) of distilled water.

The plain oils, which were all of mineral origin, had viscosities (Engler, at 50 deg. cent.) varying from 33.6 to 39.4. The content of lime water was in excess of 40 per cent but below 50 per cent.

The steam cylinder of the locomobile engine was provided with pressure lubrication of the usual type feeding 16 grams (246 grains) of oil per hour. The engine gear was abundantly lubricated in order to reduce friction losses as far as possible. Previous tests have shown that the usual indicator method of measuring cylinder performance was not sensitive enough for the present purpose and the governor was so set that at each revolution the amount of steam flowing into the cylinder was dependent exclusively on the boiler pressure. The relation between the boiler pressure and the average indicated pressure was derived through very careful indicating of the various steam pressures and was repeatedly tested during the course of the experiment.

It was found that for an operating pressure of 12 atmos. the mean indicated pressure was 5.06 atmos. with saturated and 4.93 atmos. with superheated steam. In the course of the tests the boiler pressure was maintained constant and the load varied by means of a resistance formed by a bank of incandescent lamps.

*Method of Testing.* In order to compare the lubricating ability of various oils, it is necessary to produce in the cylinder a very thin oil film, such that its wear may be observed through an increase in the energy consumed by friction. The better the lubricant the better it will adhere to the rubbing surface and the longer it will withstand the wear produced by the friction of the rubbing parts. In order to produce a sufficiently thin film of oil, the lubrication was begun in each test by supplying the usual amount of lubricant to the cylinder and then cutting it off entirely. During the period when the lubricant is supplied at the usual rate, a film of oil is built up on the inner walls of the steam cylinder. At the same time small quantities of oil collect in the piston rings and in several other dead spaces in the cylinder. When the supply of lubricant is discontinued, the film on the cylinder walls is at first maintained by supplies from these small oil reserves and its distribution from them depends on the quality of the oil. Gradually, however, the oil film is worn away by the rubbing of the parts, which causes a falling off of mechanical efficiency, which may be represented in the form of an efficiency curve. The length of the period that this decline of mechanical efficiency continues is an indication of the ability of the oil to adhere to the walls, and also of the ability of the oil to act as a lubricant even when present on the walls of an engine cylinder only in films of exceeding thinness.

In this way the lubricating qualities of the oil and its economy of consumption may be expressed in comparable figures. The economy of consumption of oils may also be determined from their minimum consumption, which means the amount of oil at which the mechanical efficiency of an engine attains its maximum value and is not improved by further additions of oil. Tests along these lines have been carried out in addition to the tests referred to above. When the supplies of oil in the cylinder were

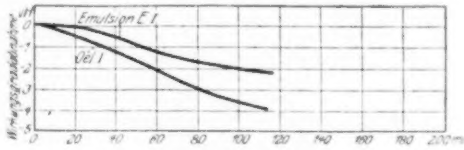



Fig. 5 Tests with Saturated Steam

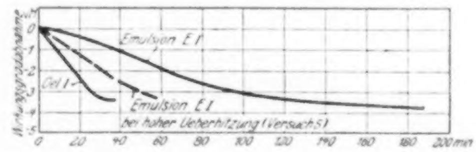



Fig. 6 Tests with Moderately Superheated Steam

Figs. 5 and 6 Comparison of Efficiency Curves of an Engine Lubricated with Oil and with an Emulsion

(*Wirkungsgradabnahme, vH.*, efficiency, per cent; *Bei hoher Ueberhitzung*, at high superheat.)

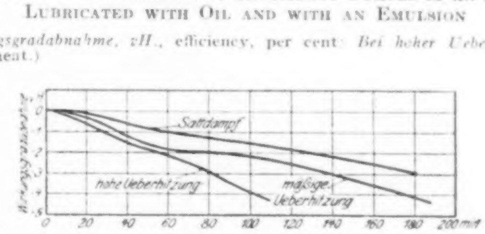



Fig. Tests with Oil Lubrication

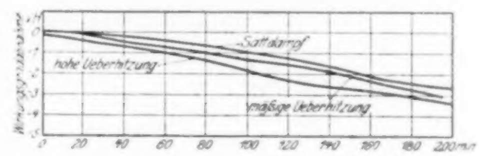



Fig. 8 Tests with Emulsion Lubrication

Figs. 7 and 8 Influence of Superheat on Efficiency Curves with Oil and Emulsion Lubrication

(*Sattdampf*, saturated steam; *hohe Ueberhitzung*, high superheat; *mässige Ueberhitzung*, moderate superheat; *Wirkungsgradabnahme, vH.* efficiency, percent.)

exhausted, a predetermined amount was forced into the cylinder and the resulting increase of efficiency determined. These tests also served to prove that the decrease in efficiency found from the previous tests was due exclusively to the gradually decreasing amount of lubricant supplied to the cylinders. If a given amount of oil forced into the cylinder was found insufficient to bring the mechanical efficiency of the engine to its original value, the amount was gradually increased until this took place. The amount of oil finally delivered which resulted in the efficiency of the engine being brought back to its original value, was the minimum amount necessary for a regular operation of the engine. In all experiments the engine cylinder at the beginning of the test was carefully washed out with a mixture of some other lubricant with gasoline.

*Data of Tests.* Figs. 5 and 6 show efficiency curves of an oil and an emulsion with saturated and moderately superheated steam. From this it would appear that the emulsion is a much better lubricant than the plain oil, especially at moderate superheat. [By moderate superheating is meant such that the steam temperature is 330 deg. cent. (626 deg. fahr.), while at high superheat it is 430 deg. cent. (806 deg. fahr.).]

Similar results were obtained with other oils and emulsions made therefrom, not only at moderate but also at the higher superheats.

From the results obtained in these tests it would follow generally that emulsions are better lubricants than the oils from which they are made, and that they maintain their lubricating properties longer when working with higher superheats. In order to bring this out more clearly Figs. 7 and 8 have been plotted, where the curves represent data of tests with an oil and an emulsion (different from those with which the tests in the two previous figures were made) with saturated, moderately superheated, and highly superheated steam. From these figures it would appear that the tests with oils produce quite divergent results, while the efficiency curves from the tests with emulsions lie very close together. From this it may be concluded that the lubricating properties of the emulsion are much less affected by the increase in the degree of superheat than those of plain oil.

In order to facilitate the comprehension of the data collected in the course of these tests, the author employs a characteristic number for denoting the variation in efficiency instead of an efficiency curve, namely, the time in minutes during which a falling off of 1 per cent takes place in the mechanical efficiency. Such numbers which may be used for comparing various lubricants are derived directly from the curves and are presented in Table 1 for saturated, moderately superheated, and highly superheated steam. From this table, again, it is readily seen that the lubricating values of the emulsions are much higher than those of the original oils from which the lubricants were made. It also appears clearly that high superheat affects oils more than emulsions containing them.

TABLE 1 TIME IN MINUTES DURING WHICH EFFICIENCY DECREASES BY 1 PER CENT

| Oil No. | Saturated Steam | | Moderately Superheated Steam | | Highly Superheated Steam | |
|---|---|---|---|---|---|---|
| | Oil | Emulsion | Oil | Emulsion | Oil | Emulsion |
| 1 | 31 | 55 | 9 | 37 | ... | 15 |
| 2 | 70 | 112 | 38 | 85 | 31 | 65 |
| 3 | .. | ... | .. | ... | 84 | 150 |
| 4 | .. | ... | 193 | 250 | 178 | 225 |

As regards the comparative consumption of oils and emulsions, it would naturally be expected that this would depend on the lubricating ability of the material. In all tests the oil feed was started at the rate of 16 grams (246 grains) per hour, which was found to be sufficient for operating the engine in the usual manner. Data of the tests having for their purpose the determination of the minimum sufficient amount of oil are presented in Table 2. Where the plus sign is affixed to a value it shows that the amount given would have to be slightly increased in the regular operation of the engine. From this table it would appear that emulsions are much more economical than the oils from which they are made.

TABLE 2 MINIMUM SUFFICIENT CONSUMPTION OF LUBRICANT IN GRAMS PER HOUR

| Oil No. | Saturated Steam | | Moderately Superheated Steam | | Highly Superheated Steam | |
|---|---|---|---|---|---|---|
| | Oil | Emulsion | Oil | Emulsion | Oil | Emulsion |
| 1 | 16 | 8 | 16+ | 8 | .... | 16+ |
| 2 | 8+ | 8 | 8+ | 8 | 16+ | 16 |
| 3 | .... | .. | .... | .. | 16 | 16 |
| 4 | .... | .. | 16 | 8 | 16 | 16 |

The number of tests, however, was not large enough to furnish data sufficient to express numerically the degree of economy presented by the emulsions. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 10, Mar. 5, 1921, pp. 248–249, 5 figs., *cA*)

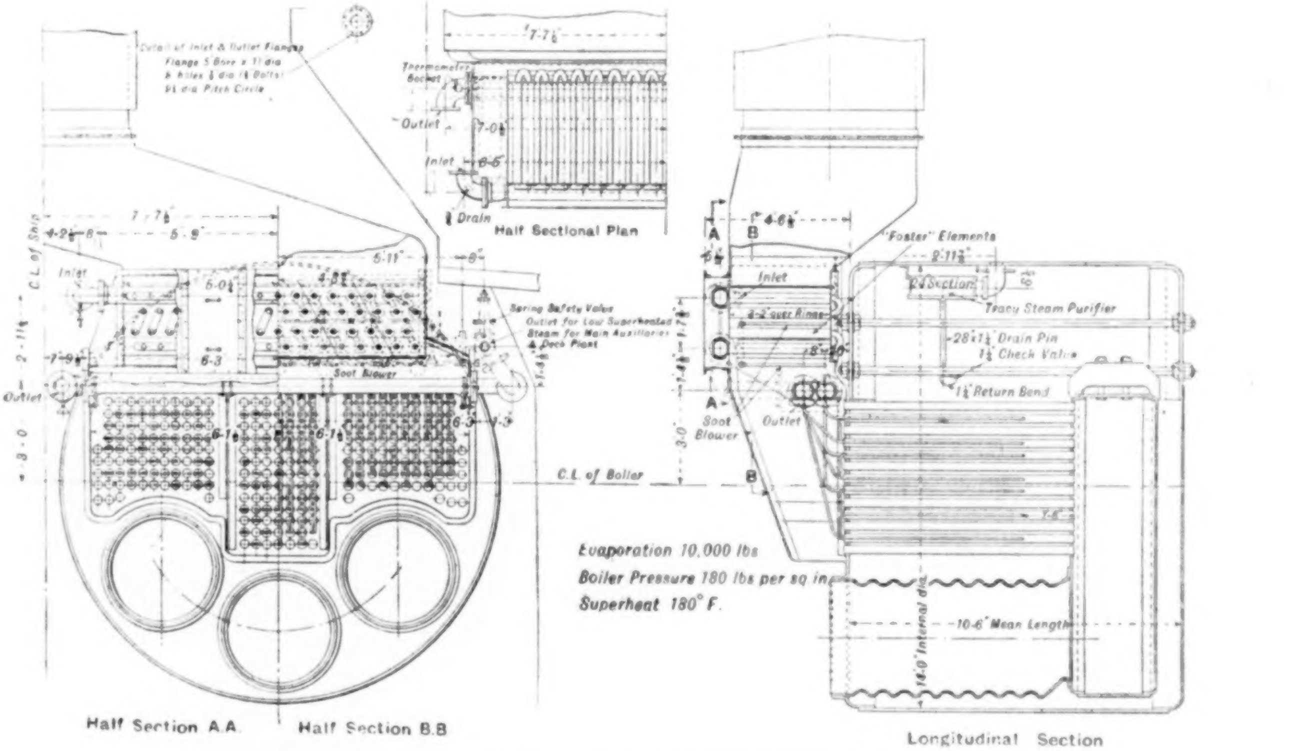



Fig. 9 Foster Double-Stage Superheater Applied to Cylindrical Marine Boiler

## MACHINE SHOP (See Special Tools)

## MARINE ENGINEERING

### A Superheater Giving Steam of Two Different Degrees of Superheat

Foster Double-Stage Superheater. Description of a combined flue-type and smoke-tube superheater giving a superheated steam to marine engines and low-superheated steam to auxiliaries, manufactured by a British company.

In the ordinary flue-type superheater the ends of the tubes nearest the combustion chamber are very liable to corrode through, which is said to be due mainly to the impinging at high velocity of the small particles of moisture which pass from the stop valve into the superheater elements. The risk of failure from this cause is somewhat reduced by the usual thickening of the tube ends, but it rather increases danger on account of the high temperature reached by the superheater elements at the bend necessary to provide the desired steam temperature inside the tubes.

The Foster double-stage superheater, Fig. 9, has a number of waste-heat elements arranged in the uptake into which the steam

from the boiler in led, as a result of which it passes into the flue elements absolutely dry and at a temperature about 60 deg. fahr. above saturation point. In addition to this, the steam as it leaves the boiler is passed through a Tracy purifier where it is freed from the impurities which otherwise would be deposited on the interior surface of the superheater.

From the waste-heat elements the steam is led to the main headers in front of the boiler leading to the flue-tube superheater elements, but before reaching the headers the steam passes through a pipe fitted with a spring-loaded safety valve and a stop valve from which steam for the main auxiliaries and the deck machinery can be drawn. This enables these engines to work economically with low-temperature superheated steam and without the disadvantages which are found to accompany a high degree of superheat.

As the steam entering the headers already contains approximately 60 deg. fahr. of superheat, the number of superheater elements is smaller, and the elements instead of being brought practically to the combustion chamber are stopped at a distance of about 1 ft. 6 in. from the ends of the tubes, and hence the tubes are not subjected to the maximum temperature of the furnace gases.

In the Foster superheater the end of the superheater tube carries a standard $^3/_4$-in. type thread (Fig. 10). The steel nut carrying a

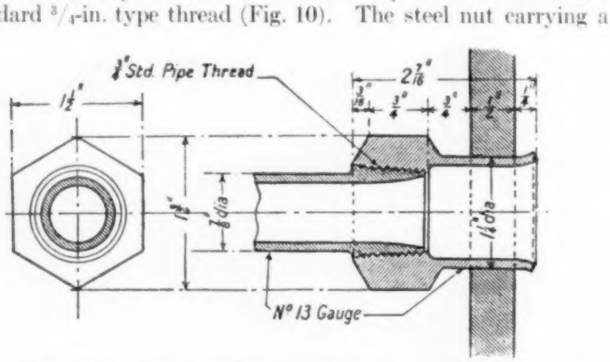



Fig. 10 Connection of Superheater Elements to Headers in a Foster Superheater

$1^1/_4$-in. diameter mouthpiece is expanded into the header. If the tube should fail, the mouthpiece can be readily removed in the usual way and only the nut will be damaged. (*Shipbuilding and Shipping Record*, vol. 17, no. 10, Mar. 10, 1921, pp. 285–286, 2 figs., *d*)

## PAPER INDUSTRY (See Power)

## PIPE

Centrifugally Cast Steel Pipe, George K. Burgess. Abstract of a report of tests carried out by the author in 1918 at the Bureau of Standards on samples from hollow steel cylinders made by the W. H. Millspaugh process.

No data as to the process itself are given, except that the cylinders were cast in a machine revolving about its horizontal axis. The cylinders are said to have walls from $^1/_2$ in. to $3^1/_2$ in. thick. The outer surfaces were fairly smooth but the interior surfaces were rough. Plain carbon- and nickel-steel cylinder castings were investigated in the condition as cast and after various heat treatments.

Results of the radial surveys for hardness and chemical analyses show there is a gradual increase in carbon from the outside to the inside surface for all castings. This increase ranges from 0.02 to 0.09 per cent and appears to be roughly proportional to the carbon content, so that the percentage in variation remains practically constant. The nickel and phosphorus appear to follow the carbon very closely in their behavior as to segregation; manganese and silicon, on the other hand, are nearly constant across the radial section, while sulphur, although somewhat erratic, in general is distributed similarly to carbon.

The hardness surveys follow closely the chemical segregation, the higher numbers occurring on the inside layers. Stresses across section of tubes were measured by cutting out rings, and it would appear that the internal stresses are of the order of the elastic limits of the material, the outer zone of the casting being in compression and the inside ring in tension.

Various attempts were made to improve these castings by heat treatment, the data of which are given in the form of tables. Most samples show good tensile strength for their composition and treatment, and there does not appear to be any marked difference in values for longitudinal and transverse specimens.

Certain of these treated steel castings would appear to compare favorably in their properties with those of forged material of the same composition. For example, the physical properties of some of the castings are equal to or better than ordnance requirements for gun forgings.

The only evidence of unsoundness of the metal was the presence of small blowholes in the inner zone, usually within $^1/_{16}$ in. of the surface.

The microstructure of some, at least, of these castings is better than that of ordinary castings; certain ones show pronounced ingotisms (dendritic structure). The nickel steels contain more slag inclusions than is usual in ordnance steel, showing that this centrifugal process may not clear up a basic steel. The ingotism and coarse-grained structures of these centrifugal castings can, in general, only be removed by prolonged and repeated heat treatments, i.e., normalizing followed by double quench and draw. (*The Iron Age*, vol. 107, no. 12, Mar. 24, 1921, pp. 764–766, 5 figs., *eA*. In this connection, attention is called to an editorial in the same issue, p. 789, discussing the centrifugal casting of steel as a metallurgical development which may become of importance.)

Manufacture of Wrought Pipe for High Pressures. For hydraulic purposes very strong pipe is required because the high pressures of hydraulic lines exert enormous bursting forces and the potential energy of the water under such working pressures closely approaches that of the thrust of a steel rod working as a piston under similar pressure.

The pipe must therefore be made with unusual care, and furthermore, to be efficient in the face of the friction developed by fluid flowing under enormous pressures and high velocities, the pipe must be clean and smooth and must be capable of bending without excessive distortion of the internal diameter. These conditions require that the pipe be welded and rolled according to the best mill practice, and from metal possessing the usual combination of high tensile strength and great ductility. The practice described below is that followed by the National Tube Company, Pittsburgh, Pa.

To make pipe for hydraulic purposes the solid ingot is rolled down to plates of the required dimensions, which eliminates laminations occurring in plates rolled from built-up bars and insures homogeneity of the pipe wall. Defects such as blisters or blowholes are obviated in the skelp from which pipe is made by a mechanical process of working the metal in bloom form known as "Spellerizing." It is a kneading process which consists of subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surfaces.

High-pressure pipe of smaller sizes is manufactured by the butt-welding process. The hot plate is welded into pipe at a point close to the end of the furnace by drawing it through a die shaped like a bell with a hole in one end. The pipe is reheated several times and drawn through dies having gradually decreasing diameters until the proper size is obtained. This is done in order to weld thoroughly the very thick abutting edges of the seam and to provide the necessary strength at this point. When pipe is not intended for high-pressure service, it is drawn through only one or two dies.

The larger sizes of pipe for high-pressure purposes are made by a process in which the edges of the plate are overlapped by the seam. The plates are properly rolled, heated and bent into rough tubes (skelp), and are then charged into a furnace where they are heated to a welding temperature. From the furnace they go into the revolving rolls of the welding apparatus, so grooved that they form a circular opening between them of approximately the same

size as the outside diameter of the pipe. In this opening is a bullet-shaped mandrel, and as a skelp comes from the furnace it is caught by the rolls which force it forward over the mandrel and press the overlapping edges together into a sound weld.

To make one length of the strong pipe used for certain purposes, two lengths of pipe are welded in this manner and then telescoped, this being arranged in such a way that the welds of the telescoped pipes are at diametrically opposite points. In this position they are reheated to a welding temperature and are both passed at once through the welding rolls, thus forging them into a single length of heavy-walled pipe.

After the pipe has been welded it is passed through rolls which give it the required outside diameter, and through cross-rolls to straighten it and give it its true circular shape. The pipe is then slowly cooled on a continuously traveling table, after which the tags and the ends which have become damaged in manufacturing are trimmed off and the pipe is subjected to a hydraulic test to prove the soundness of wall and weld. The test pressures vary from 700 to 3000 lb. per sq. in. according to pipe size and type of weld.

Hydraulic pipe is made in nominal sizes of 9, 10, 11, and 12 in., and is tested with hydraulic pressures of from 1200 to 1800 lb. per sq. in., depending upon the size and upon the wall thickness. Each of these sizes is made in four different thicknesses and weights.

Making wrought pipe for high pressures is extremely exacting work, and such is the necessity of keeping the closest possible control on all the materials going into its manufacture that, e.g., at the plant of the National Tube Company—the largest manufacturers of this pipe in the country—everything from the ore to the finished product is made in the plant. (*Machinery*, vol. 27, no. 8, Apr. 1921, pp. 755–756, 5 figs., *d*)

## POWER

### Gear Drives in British Textile Mills

The Individual Gear Drive for Heavy Looms, G. F. Sills. Plenty of evidence is available in British practice to uphold the advantages claimed for the individual gear drive. As an instance, it is stated that the largest electrical individually driven weaving shed in the country up to the time of the armistice had 1162 plain, narrow-reed-space Lancashire-type looms individually belt-driven, each with its own motor. When a large extension was contemplated the owners went into the matter carefully and finally ordered a further 570 individually driven units equipped with a more expensive gear drive, in spite of the fact that the looms were of a

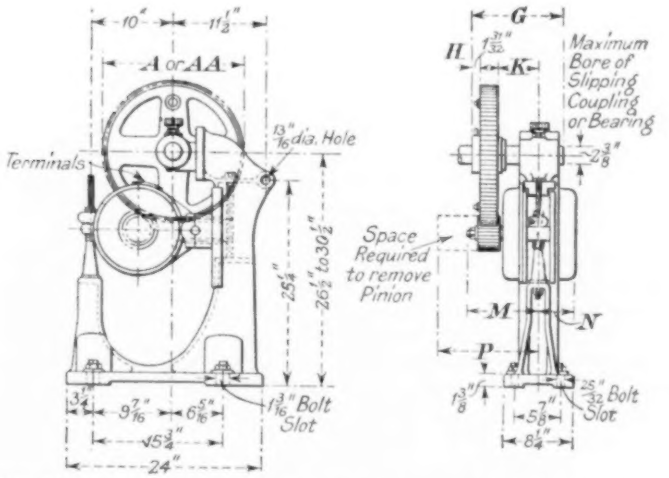



Fig. 11 Standard Loom Motor with Gear Drive ($^3/_4$ to $1^1/_4$ Hp.)

relatively cheap type and were weaving an article which did not command a high market price.

Fig. 11 shows a view of the latest electrical individual gear drive suitable for equipment up to $1^1/_4$ hp., made by the English Electric Company. (A number of similar equipments of only $^1/_2$ hp. have been supplied to the textile trade.)

This form of gear drive is claimed to be better built than was the case formerly. The pedestal section is stiffer and the pedestal casting is so arranged as to give heights of centers from the floor varying between $26^1/_2$ in. and $30^1/_2$ in. This means that the pedestal casting would be the same for the horsepower range from $^3/_4$ hp. to $1^1/_2$ hp.

Other improvements are the stiffer conical pin which holds the motor clamp in position, and an eyebolt which is supplied to fit on to this pin for carrying the stiffening rod back to the loom frame. A boss is also provided on the pedestal for carrying a second stiffening rod to the loom frame. The centers of the holding-down foundation bolts are the same as those on the old-type pedestal, thus allowing the new-type pedestal to replace the old-type without any considerable amount of alteration. This pedestal is also designed to allow of a loom crankshaft speed of 76 r.p.m. This particular gear drive is suitable for the ordinary loom.

Where the power required is over $1^1/_2$ hp. a much more substantial form of drive is used than that shown in Fig. 11. In this type the motor is not supported centrally, but has special end shields which are clamped to two side supports coming up from the pedestal. This has the advantage of transmitting shocks and power from the pinion to the ball bearings, thence to the end shields, and finally to the pedestal without in any way straining the stator of the motor.

In this extra heavy type of drive a slipping clutch is used for absorbing the shock of the motor pinion in the event of a "bang-

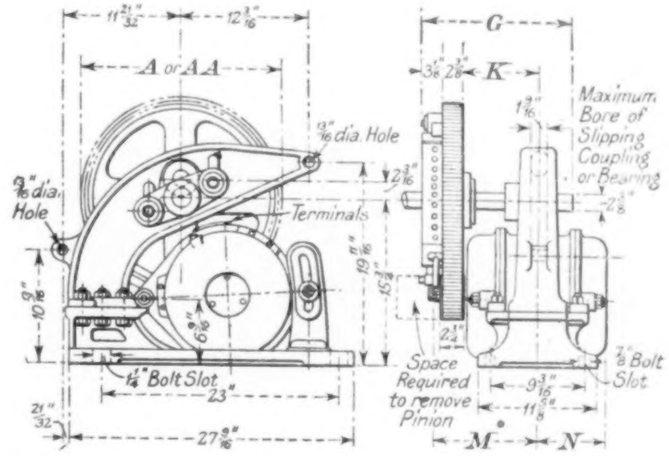



Fig. 12 Extra Heavy Individual Gear Drive for Looms with Low Centers

off," as there is considerable momentum stored in even a small motor rotor running at 965 r.p.m. The central cast-iron boss is a light force fit on the loom shaft to which it is keyed, and is also provided with three studs. The spur wheel is bored to be a loose revolving fit on a portion of the central boss, previously referred to, but is kept from turning on this by the spring bands which are adjustable for tension. At starting there should be no slip, and the correct setting is obtained by making a chalk line to cross the spur wheel and central boss with the loom stationary. The loom should be started up and stopped in the ordinary way, when the spur wheel and central boss should still be in the same relative position to one another. If there are any signs of slipping, which is clearly indicated by the chalk line just mentioned, the springs should be tightened until there is no movement. With this setting there should be a relative movement of from 1 in. to $1^1/_2$ in. on a "bang-off."

For looms with low centers (some as low as $15^3/_4$ in.) the drive shown in Fig. 12 is used. Loom motors are made specially for the purpose and are totally enclosed and equipped with ball bearings and grease lubrication requiring no attention for long periods. The starting torque of a loom motor is about $2^1/_2$ times that of the normal type. The temperature rise is only 35 deg. cent. as against 50 deg. cent. for the same type of commercial motor. (*The Electrician* (London), vol. 86, no. 2229, Feb. 4, 1921, pp. 150–153, 8 figs., *d*)

## POWER GENERATION

### Economic Features of Superpower Schemes

Industries and Superpower, Harold Goodwin, Jr. The cost of fuel and purchase of power for all the industries in the United States amounts to only about $2^1/_2$ per cent of the value of the products and is only about $4^1/_2$ per cent of the value of the materials going into these products. (These figures apply to the country at large and not to individual industries.) Nevertheless the subject of power generation and distribution is, of course, of the highest importance.

As regards the determination of the future load, Dr. George Otis Smith, Director of the U. S. Geological Survey, has pointed out that the steam engine has been the cause of centralization of industry, while electricity has already been the means of decentralization, and the greatest mission of the superpower system should be the aiding of industry in its economic decentralization.

Fig. 13 shows the method of determining the limit of saturation

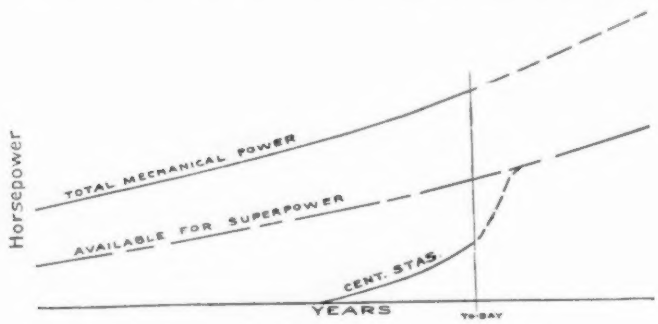



Fig. 13 Growth of Industrial Mechanical Power

of industries with power. The upper curve shows the growth of the total mechanical power and the growth which may be predicted for it in the future, while the next curve shows the proportion of the load which could be economically supplied by central-station service. The lower curve shows the growth of central-station power and the way its logarithmic extension would continue. It is evident that the limit of central-station supply of mechanical power should be reached if the present rate of growth is maintained for a few years, and that after the point of saturation has been reached the growth will be much more gradual.

This consideration would show that it is not safe to predict the load of the superpower system simply by the extension of the present growth curve of central stations.

The location of industries is determined by many factors, such as labor, transportation, raw-material supply, etc. In some cases there seems to be a tendency for industry to move to the nearest supply of labor; while in others plants have made arrangements for drawing labor to them instead of carrying the plant to the labor. Availability of power through the superpower scheme may be of assistance in facilitating the location of plants on sites otherwise desirable. If there is a tendency of industry to decentralize, availability of power will be one of the controlling factors in the building up of new industrial centers. (*The Journal of the Engineers' Club of Philadelphia*, vol. 38-2, no. 194, Feb. 1921, pp. 63-68, 5 figs., *g*)

Superpower Stations for Central Indiana, Frederick L. Ray. General outline of the needs, advantages and possibilities of a system of generating stations located in coal-mining districts and supplying the entire central part of the state. Credit for many of the ideas advanced is given to John A. Stevens, Mem. Am.Soc.M.E.

In this project primarily developed for central Indiana but which could be extended to cover practically all of Indiana and the eastern half of Illinois, it is intended to locate the power plant on the Wabash River because a project of this kind cannot be considered unless there is an abundance of water for condensing purposes, a condition which is fully satisfied by the Wabash River. The intention is to erect several plants of about 150,000 kw. capacity each in the coal field on the river between Terre Haute and Vincennes.

A table in the original article shows the approximate kilowatt-hours generated per month for some 25 cities of central Indiana, from which it appears that the total output is close to 45,000,000 kw-hr. per month produced at a cost of about 95,000 tons of coal, with a consumption of coal per kw-hr. varying from 3.20 to as high as 9.66 lb. and averaging about 4.5 lb. per kw-hr.

This current could be generated in a modern plant for 2.12 lb. of coal per kw-hr., including 30 per cent transmission losses up to the consumer, which would mean a saving estimated at more than 48,000 tons of coal per month, equivalent to a saving per year of approximately 600,000 tons.

The general outline of the design of the plant is given. It is intended to make provision on each boiler for the burning of powdered coal to the extent of 50 to 200 per cent of the normal demands. Then in an emergency it would be possible to increase the output to 400 per cent without crowding the stoker. The mixture of the flame from the powdered coal with that of the flame from coal and stoker would greatly improve combustion, and the trouble of ash removal with powdered-coal burning would be eliminated, for the ashes from the powdered coal would fall upon the ash and refuse from the stoker and could be readily dumped to ash pit and removed.

The railroads in this district should be electrified as quickly as possible, but not until all other industries have been taken care of. (Paper read before the Indiana Engineering Society, abstracted through *Power Plant Engineering*, vol. 25, no. 5, pp. 262-264, 1 map, *g*)

Superpower Zone in Canada, Robt. G. Skerrett. The author claims that Canada has set the pace for the United States in the creation of what may properly be termed a superpower zone, referring to the work of the Ontario Hydroelectric Power Commission.

Ontario, which is one of the most densely populated sections of the Dominion, is practically devoid of its own sources of fuel but has a large potential supply of water power. It was to develop this that the Commission was created in 1906. (Its powers and organization have been since modified by a number of subsequent acts of the Canadian Parliament.)

At the beginning, the main attention of the Commission was devoted to the development of the Niagara project. Later on, however, eleven other districts were covered and last year the transmitting wires distributed more than 315,000 hp., while it is expected that by the close of 1921 the total output for public use will amount to 750,000 hp. and will be approximately doubled in the next two years.

The charges for electric energy are such as to cover the expense of the service and create a sinking fund which in 30 or 40 years will leave each constituent community the owner of its plant.

Generally speaking, 1 hp. raised by steam entails an outlay in Canada today of from \$40 to \$60 annually, whereas the Commission is able to sell a hydroelectric horsepower for only \$18 for a twelvemonth.

An interesting feature of the rate-making system of the Commission is found in the fact that in each community the small user pays for energy the same price as the large consumer, and the rate in each locality is determined on its individual merits. The dominating purpose of the Commission is that there shall be an equality of right to power in all areas within range of the current generated in any of its plants.

In the early days the Commission bought all its supplies from dealers. Now, however, with its expanded organization, it buys lamps and other equipment in large quantities direct from manufacturers, giving the consumer the benefit of the cheaper price.

The installations owned by the Commission (not including franchise valuations) represent a cash value of close to \$57,000,000. The Niagara power development cost \$15,000,000 and the combined valuation of the Commission is well in excess of \$100,000,000. (*Scientific American*, vol. 124, no. 13, Mar. 26, 1921, pp. 246 and 258, 1 map, *d*)

## POWER-PLANT ENGINEERING (See also Lubrication and Marine Engineering)

### Canals as Sources of Condenser Water for Large Plants

The Cooling of Water in a Canal, L. C. Kemp. Description of a recent series of experiments carried out in England, and of interest because of a number of large power stations which are being erected on canal sites.

The Lero Road power station of the city of Leicester is situated on the banks of a canal, upon which it relies entirely for the cooling of circulating water for the condensers. It has approximately 9500 kw. of plant installed, comprising a turbine and reciprocating machinery supplied from different circulating systems. The inlet and outlet circulating-water ducts are separated by less than 200 yd. but sufficient cooling is available to operate the station satisfactorily.

The tests were carried out primarily to determine in a qualitative sense the conditions assisting the dispersal of heat in the canal, and also to establish, if possible, heat-gradient charts and an approximate dispersal factor which would be of value as a basis in determining the probable performance of proposed new power stations for similar sites. In the tests the following quantities were determined:

- The heat quantity entering the canal from various sources.
- Temperature of the canal surface in the area affected by the heat currents.
- Atmospheric conditions.
- Heat carried away through the lock.
- Heat stored or released from the bulk of the water quantity affected, due to difference in average temperature before and after the test.
- Cooling effect of cold river water entering the system to provide make-up for the water evaporated.

During the test the temperature of water showed a net increase at all points, and in order to gage the quantity of heat thus stored it was decided to measure approximately the total volume of the water in the area affected. To do this soundings were taken at selected sections of the basins, pool and stream.

As the temperature variations in certain portions of the area would be greater than in others, it was decided to divide the total area into zones over which the temperature variations were not large. Then:

$$\left\{\begin{array}{l}\text{Total heat stored}\\ \text{in the four zones}\end{array}\right\} = \Sigma \left\{\begin{array}{l}\text{Weight of water}\\ \text{in each zone}\end{array}\right\} \times \left\{\begin{array}{l}\text{Net rise in}\\ \text{temperature}\end{array}\right\}$$

The net rises in temperature between 10 a.m. and 4 p.m. have been obtained from an average of the rises recorded in Fig. 14.

The approximate dispersal factor was determined in the following manner:

Let $\rho$ = dispersal factor of the day in B.t.u. per sq. ft. of water per hour per inch Hg difference in the vapor pressures corresponding to the water-surface temperature and the atmospheric wet-bulb temperature.

Average wet-bulb temperature reading = 49 deg. fahr.

Corresponding vapor pressure (V. P.) = 0.334 in. Hg.

$$\begin{array}{l}\text{Total heat quantity}\\ X \text{ dispersed from}\\ \text{the canal surface}\end{array} = \rho \times \Sigma \left\{\begin{array}{l}\text{(Area of each zone in sq. ft.)} \times\\ \text{(V. P. Hg corresponding to average}\\ \text{surface temperature—V. P. corre-}\\ \text{sponding to atmospheric wet bulb)}\\ \times \text{(Time in hours)}\end{array}\right.$$

$$\begin{aligned}461.8 \times 10^6 &= 31{,}200\,\rho \times (1.04 - 0.334) \times 6 \text{ (Basin A)}\\ &+ 23{,}900\,\rho \times (1.15 - 0.334) \times 6 \text{ (Pool)}\\ &+ 13{,}000\,\rho \times (0.93 - 0.334) \times 6 \text{ (Basin B)}\\ &+ 42{,}400\,\rho \times (0.82 - 0.334) \times 6 \text{ (Upstream zone)}\\ &= (132{,}000 + 117{,}000 + 46{,}500 + 123{,}500)\,\rho\\ &= 419{,}000\,\rho\end{aligned}$$

or

$$\text{Dispersal factor } \rho = \frac{461.8 \times 10^6}{419{,}000} = 1100 \text{ B.t.u. per sq. ft. per hr. per in.}$$

**Hg difference in the vapor pressures corresponding to water-surface temperature and atmospheric wet-bulb temperature.**

This factor represents the rate of cooling which actually took place during the test period and is therefore applicable only where the atmospheric and geologic conditions are similar. In conjunction, however, with heat-gradient charts its may be useful as a foundation on which to base an estimate of the degree of assistance which may be expected under particular conditions at other canal sites.

The investigation demonstrates strikingly that cooling is effected largely outside the circuit followed by the water between the circulating-water discharge and intake. The distance between these may be relatively small, but the heat will leave the circuit followed by the water and flow for a considerable distance along the canal,

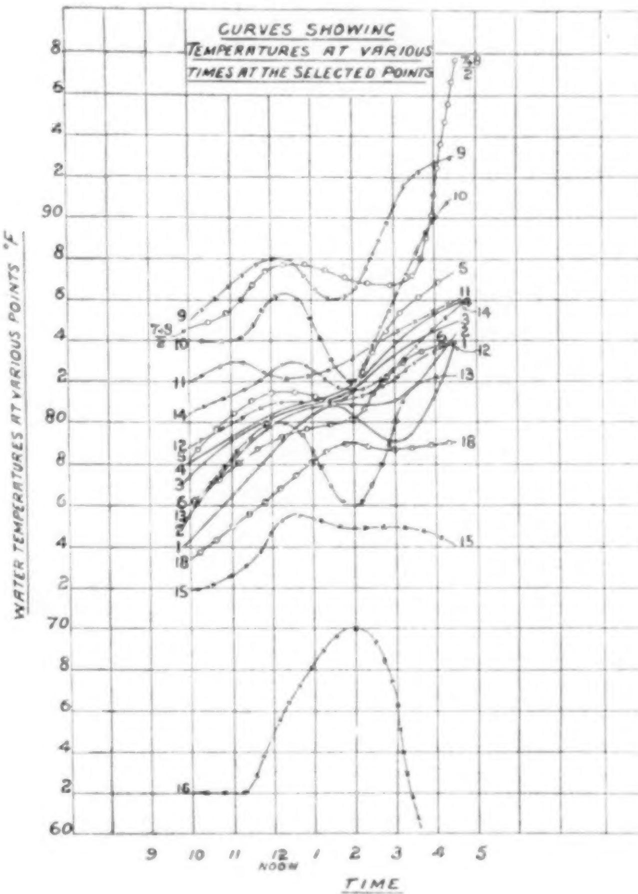



Fig. 14 Curves Showing Temperature at Various Times at Selected Points in the Canal Used as a Source of Condenser Water

thus increasing the cooling zone more or less adequately. In this case the heat actually flowed upstream for nearly a quarter of a mile against a slow current. (*The English Electric Journal*, vol. 1, no. 5, Jan. 1921, pp. 210–222, 8 figs., *ep*)

Proportioning Chimney Heights, Robt. Sibley and C. H. Delany, Members Am.Soc.M.E. The authors propose a method for ascertaining the diameter and height of chimneys in which a table and diagram given in the original article are used. It is claimed that by these means the fundamental dimensions of a chimney to produce a given amount of draft can be determined regardless of the kind of fuel used, provided the quantity of flue gas passing per hour can be approximately estimated.

In its turn the weight of flue gas passing per unit of time is said to depend for practical purposes on the weight of fuel burned and the percentage of excess air used in burning it.

This method is of interest as, in addition to giving the dimensions, it also apparently indicates the various combinations of heights and diameters of stacks to produce a given draft for the particular weight of flue gas considered.

The rule for altitude correction is given, and examples for calculating chimneys at sea level and at altitudes presented. (*Journal of Electricity and Western Industry*, vol. 46, no. 6, Mar. 15, 1921, pp. 299–300, 1 fig. and 1 table, *p*)

## POWER PLANTS

Centrifugal Oil Cleaner. Description of a device developed at McCook Field, Dayton, Ohio. It consists of a spun copper bowl 5 in. in diameter and $1^1/_2$ in. high, mounted in a modified Liberty oil pump. It is driven by a steel shaft splined into the lower oil-pump gear of the Liberty-12 oil pump. The speed of this shaft is $1^1/_2$ times the crankshaft speed.

The oil is led from the oil tanks to the inside of the bowl which is rotating at 2550 r.p.m. when the engine is turning at 1700 r.p.m. The oil is set into centrifugal motion and all foreign matter of greater specific gravity than the oil is thrown and held to the inside edge of the bowl. A number of runs were made both with mineral lubricating oil and castor oil. In this latter test cold oil was mixed with fine emery powder, metallic filings and sand, which changed the color of the oil to a dark gray. After being run through the cleaner once the mixture emerged as clear as it was before it was mixed, and all of the emery, metallic particles and sand remained in the bowl.

The next test was made on a Liberty-12 engine run for 10 hr. at 1650 r.p.m. on a testing stand. The oil was not renewed during the run and after it was concluded the oil was emptied and the inside of the bowl carefully examined. It was found to be covered with a gummy deposit, in which a variety of substances were imbedded.

A study of the grit collected from the run reveals a large amount of iron and steel, which must have come from the piston rings and cylinder. There was also a large percentage of a very fine aluminum powder, which must have come from the pistons. A small quantity of bronze powder was observed, also babbitt bearing metal. Small chips resembling those from machining processes were present and also sand varying from very fine powder to small pebbles, and carbon in various forms and sizes. The sand may have come from the core sand that could not be cleaned out of the casting. There were also fine, brown particles that looked like sand but crushed easily and were presumably made up of dust taken in through the breather. The power required by the cleaner at 2250 r.p.m. varies from 1 hp. at 75 deg. fahr. to 0.35 hp. at 190 deg. fahr. (*Oil News*, vol. 9, no. 4, Feb. 20, 1921, pp. 21–22, 2 figs., *d*)

## SPECIAL TOOLS

Boreas Cast-Iron Refuse Briquetting Machine. Description of a pneumatic press for briquetting cast-iron refuse.

It is claimed that by converting cast-iron filings and turnings into briquets not only can this material be usefully employed but the quality of the melt can be improved by making possible the introduction of silicon or manganese into castings in definite and concentrated form.

In the manufacture of the briquets cast-iron turnings and slaked lime are used, and the following mixture is quoted: 2 cwt. cast-iron turnings, 5 per cent slaked lime and 5 per cent water. The briquets made from this mass are placed on drying trays, allowed to remain there for some days, after which they are sufficiently hard to be piled for tempering. This latter, which generally takes from two to four weeks, depending on the water, can be done in the open air.

In dry weather it is advisable to water the briquets occasionally. Moisture in combination with the iron and lime gives a chemical reaction which forms a hard shell around the briquet. This is desirable as a final result, because it renders the briquet more suitable for handling, but must be avoided in the beginning as it might prevent the proper hardening of the inside.

If used in the cupola, they can be placed by means of a shovel, first of all filling in raw iron and old iron, thereafter the briquets, and lastly the cinders which act as a buffer to the following layer of raw iron and prevent the briquets from being crushed.

The "Boreas" press is adapted for pneumatic power and also for belt drive. In the first type the machine is a knee-joint press with the cylinder for compressed air suitable for pressure of 6 to 7 atmos. The belt-driven press is also of the knee-joint type but has a spindle instead of the air cylinder. The press makes three strokes per minute at a pulley speed of about 275 r.p.m., the power consumption being about $4^1/_2$ hp. The weight of the apparatus is approximately a ton and a half. (*Foundry Trade Journal*, vol. 23, no. 229, Jan. 6, 1921, p. 20, 1 fig., *d*)

## STEAM ENGINEERING (See also Marine Engineering)

### Rotary Steam Engines with Michell Thrust Bearings

Michell Crankless Steam Engine. Description of a high-speed engine designed by A. G. M. Michell, inventor of the Michell thrust block, for the purpose of testing whether by the use of these blocks it was practicable to construct crankless internal-combustion or steam engines which would presumably be lighter than engines of conventional type.

In the Michell engine the crank is replaced by a swash plate,

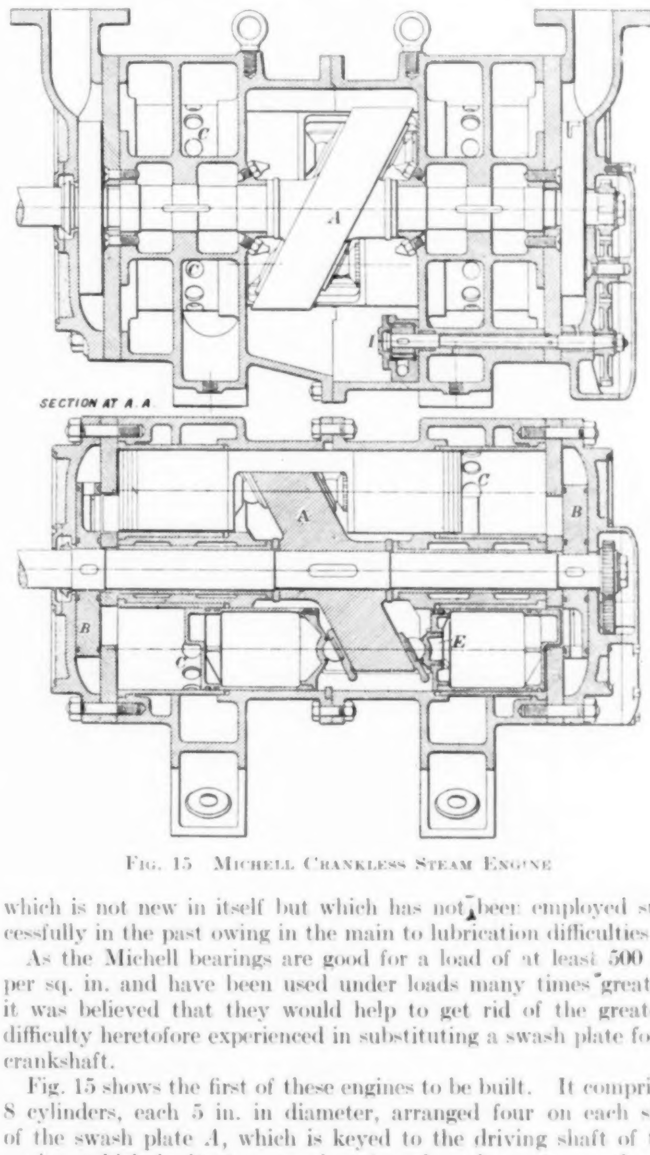



Fig. 15 Michell Crankless Steam Engine

which is not new in itself but which has not been employed successfully in the past owing in the main to lubrication difficulties.

As the Michell bearings are good for a load of at least 500 lb. per sq. in. and have been used under loads many times greater, it was believed that they would help to get rid of the greatest difficulty heretofore experienced in substituting a swash plate for a crankshaft.

Fig. 15 shows the first of these engines to be built. It comprises 8 cylinders, each 5 in. in diameter, arranged four on each side of the swash plate *A*, which is keyed to the driving shaft of the engine, which in its turn carries at each end a rotary valve *B* controlling the admission of steam to the cylinders. The engine works on the uniflow principle, the exhaust being discharged through ports *C*, of which there are eight for each cylinder, each $1^1/_8$ in. in diameter.

The pistons on opposite sides of the swash plate are rigidly connected in pairs to form a single unit, the weight of the unit being adjusted to that of the swash plate so as to secure perfect running balance. (Formula given in the original article.)

The thrust of the pistons is transferred to the swash plate through Michell blocks which are mounted on spherical seats,

and an ample supply of oil is maintained by means of a gear-driven pump.

Provision is made for adjusting the distance between the Michell blocks on opposite sides of the swash plate as at *E*. To permit this, one of the ball sockets is mounted on a screwed sleeve which can be adjusted by turning it by the notched head.

The engine was designed to run at 1200 r.p.m., but the tests have shown that this limit can be greatly exceeded. In the tests the steam was supplied at a gage pressure of 150 lb. per sq. in. and exhausted to a condenser in which a vacuum of 26 in. was maintained.

The swash plate was held at an angle of $27^1/_2$ deg., but Mr. Michell intends to reduce this in future engines to $22^1/_2$ deg., since the tests showed that the larger angle was unnecessary. The horsepower developed was 0.92 i.hp. per cylinder per 100 r.p.m., and it is believed the engine can be run at speeds up to 1500 revolutions. (*Engineering*, vol. 111, no. 2880, Mar. 11, 1921, pp. 290–291, 5 figs., *dA*)

## TEXTILE INDUSTRY (See also Power)

Attention is called to the issue of *The Electrician* (London), vol. 136, no. 2229, February 4, 1921, containing several articles of interest to the textile industries, one of which, on Individual Gear Drive for Heavy Looms, is abstracted on a previous page under the heading Power. The other articles are: Some Considerations in the Application of Electricity to Textile Mills, by J. T. Randles, discussing estimates of power requirements, switch gear, electrification of new mills, balancing of group drives and the advantage of constant speed and steady turning which electric driving gives; Modern Methods of Driving Machines in Jute Manufacture, by T. Wodehouse and P. Kilgour, which discusses among other things the speed problem, methods of driving, carding processes, preparation of the warp and weft, cop winding and the various drives such as dressing-machine, loom and calender drives; and Continental Practice in the Electrical Driving of Textile Factories, by W. Dundas Fox, which is illustrated by numerous curves taken on various machines.

## TUBING (See Pipe)

## VARIA

### Flotation Method of Separating Coal from Slate and Rock

FROTH FLOTATION APPLIED TO THE SEPARATION OF COAL. Various methods of separating coal from slate and rock have been tried, such as separation by heavy liquids, air separation, etc. At present the most usual system is washing the coal in jigs, but the Mineral Separations Company, which made a big success of the flotation process as applied to the separation of metallic ores, is now trying to employ the same principle for coal.

The new system comprises several separate operations. In the first place the coal has to be ground so that the particles will pass through a screen of $^1/_{16}$ linear inch aperture. It is then mixed with from four to six times its weight of water and the mixture agitated, either by means of a rotary agitator or by an injection of air, while a small quantity of a special reagent is added. The reagent may be an oil or a coal-tar product, and it is stated that some industrial waste products may be so used. Approximately a pound or so of the reagent is required for each ton of material treated.

The agitation in presence of the reagent produces a multitude of minute air bubbles which attach themselves to the coal particles and bring the latter to the surface, while the ash-forming slate sinks to the bottom. The process is of a continuous character, the material circulating through the plant until all the economically recoverable coal has been extracted.

It is claimed that the process is applicable to the removal of dirt and of non-combustible matter from crushed coal destined for coking purposes, the preparation of clean coal for the manufacture of briquets, and the recovery of coal from screenings or old pit heaps.

As regards the plant itself, it appears that the dimensions of one having a capacity of 600 to 1000 tons per 24 hr. are: length, 37.5 ft.; width, 16 ft.; and height, 15.5 ft.

A feature of the flotation system is the facility with which one grade of coal, by means of reagent control, is separated from another grade without screening or classification. Thus a coal comprising pure coal (i. e., no free ash, only fixed ash), bone coal and shale is separable into its component parts, so that the pure coal can be separated and the bone coal left with the shale; the bone coal can be separated from the shale and included with the pure coal, or else separated from the shale for boiler, locomotive, or producer use. Apart from the separation and recovery of the good coal contained in waste and low-grade coal, there are certain special advantages as regards the application of the system to the cleaning of coking coals. Ash reduction reduces cost of handling and permits of a larger efficient charge to the coke oven; richer gas and larger quantities of by-products are yielded, and a harder, denser and sufficiently porous metallurgical coke is obtained.

The following typical separation was effected in the cleaning of a coking coal carrying 10.14 per cent of ash in the raw state:

| | Pure Coal | Bone Coal | Shale |
|---|---|---|---|
| Per cent by weight | 87.20 | 2.4 | 9.5 |
| Ash content, per cent | 3.25 | 19.2 | 72.1 |

Obviously the bone coal can be mixed with the high-grade coal if required, but in this particular case it was proposed to make from the pure coal a high-grade coke carrying from 5 to 5.5 per cent of ash and to employ the bone coal for boiler or producer use, rejecting the shale as waste. (*The Iron and Coal Trades Review*, vol. 102, no. 2763, Feb. 11, 1921, p. 197, *g*)

TRIAL FLIGHTS AND ACCEPTANCE TESTS FOR NEW TYPES OF AEROPLANES. A. G. H. Fokker. The ideal test pilot is, or should be, the designer of the machine. Unfortunately, this combination is very rare, and the designer has usually to rely on reports of others as to the properties of his machine. Until reliable recording instruments are in our possession, the "personal element" will predominate in the tests and "scientific" pilots are not always available.

The following are the main characteristics which an aeroplane should possess, and on which the test pilot should concentrate his attention:

*Getting Off.* The machine should possess sufficient directional stability while running along the ground. As soon as the flying speed is reached it should be able to get off without the use of the elevator.

*In Flight.* There should be no hunting, either in the horizontal or the vertical direction. The changing over from "power-flight altitude" to "gliding-flight altitude" should be automatic and quick. Even at the lowest flying speeds wing-flap controls should be possible. When executing curves there must be no tendency to go into a nose dive or spin. When side-slipping the machine should still be controllable. All rudder organs should be properly balanced.

*Landing.* Smooth landing depends very much on the type of landing wheels and their position. By proper construction, any tendency to leave the ground again can be checked. (*Het Vliegveld*, Jan. 1, 1921, abstracted through *The Technical Review*, vol. 8, no. 11, Mar. 15, 1921, p. 256, *g*)

## WASTE UTILIZATION (See Special Tools)

# CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

# ENGINEERING RESEARCH

## A Department Conducted by the Research Committee of the A.S.M.E.

### Sir Robert Hadfield Prize

SIR Robert Hadfield has offered through the Institution of Mechanical Engineers of Great Britain a prize for the best design of an apparatus to determine the hardness of materials accurately and suitable for application in metallurgical work for cases in which present methods partially fail. The award or awards will be made by the Council of the Institution. The present funds amount to £154 sterling. A portion of the fund may be awarded for communications which advance the knowledge of the methods of testing hardness. Communications should be accompanied by scale drawings or by models or examples of the apparatus. If the communication is likely to be of commercial value, provisional protection should be obtained before submitting it. Address the Secretary, Institution of Mechanical Engineers, Storey's Gate, St. James Park, Westminster, London, S. W. 1, marked "Method of Determining Hardness." Communications should reach him by December 1, 1921.

### Research Associations in Great Britain

The number of British Research Associations under the license of the Board of Trade acting through the Department of Scientific and Industrial Research now totals twenty-three. Sixteen of these associations have already been listed in the issues of MECHANICAL ENGINEERING for March, August and November, 1920 (pp. 181, 470 and 638). The seven additional associations are:

The British Leather Trades Research Association, 26 Thomas Street, London, S. E.; Secretary, Miss M. A. Stevens.

The British Launderers' Research Association, 62–5 Bank Chambers, 329, High Holborn, London, W. C. 2; Secretary, J. J. Stark.

The British Electrical and Allied Industries Research Association, 19 Torhill St., Westminster, London, S. W. 1; Director of Research, E. B. Wedmore.

The British Silk Research Association, The Silk Association of Great Britain and Ireland, Inc., Kingsway House, London, W. C.; Secretary, A. B. Ball.

The British Motor and Cycle Car Research Association, "The Towers," Warwick Road, Coventry; General Manager, H. R. Watling.

The British Cutlery Research Association, P. O. Box 49, Sheffield; Secretary J. M. Denton.

The British Music Industries Research Association, Northern Polytechnic Institute, Holloway, London, N. 7; Director of Research, Dr. R. S. Clay.

The British Jute Industry Research Association and the British Cast Iron Research Association have been approved by the Department of Scientific and Industrial Research, but as yet have not been licensed by the Board of Trade.

The British Aircraft Association and the British Association for Liquid Fuels for Oil Engines have proposed their memoranda and articles of association. Certain other associations are engaged in preliminary considerations.

---

The International Research Council at Brussels has started an inquiry regarding the possibility of an international auxiliary language for the purpose of reporting scientific matters.

### Research Résumé of the Month

#### A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

*Apparatus and Instruments A3-21.* RESISTANCE THERMOMETERS. The experience of the Bureau of Standards in the construction of resistance thermometers and a description of the resistance thermometers in use have recently been published as a scientific paper. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

*Apparatus and Instruments A4-21.* SAMPLING TUBES FOR STEAM. Tests to indicate the best position of sampling tubes have been made at West Virginia University by Carl H. Cather and H. S. Dilcher. To determine the true value of the quality of the steam for which different calorimeters had been used in connection with various forms of sampling tubes, the entire steam remaining in the pipe from which the samples were taken was allowed to discharge through a 1/4-in. orifice into a 5-in. drum 15 in. long. The temperature of this steam after the throttling action had taken place was determined by a resistance thermometer placed in the drum. The average pressure of the steam at the top and bottom of the drum was also determined. By assuming that the quality of the steam determined by this device, which was called a standard calorimeter, was correct, the errors of the various calorimeters could be found. The results show that in many cases an error of almost 2 per cent can be obtained. From certain sampling tubes errors of both positive and negative value were determined. The results indicate that the best form of sampling tube is one in which the holes are drilled in straight lines and the holes are 1/8 in. in diameter. The results are more uniform and have a smaller value when used in a descending current of steam. Small holes 1/16 in. in diameter are not as good as holes of larger size. Address Prof. John B. Grumbein, West Virginia University, Morgantown, W. Va.

*Cellulose and Paper A1-21.* TESTING OF PAPER. Circular No. 107 of the Bureau of Standards is devoted to paper testing. It may be obtained from the Superintendent of Documents at 10 cents per copy. It describes the method of testing paper and the apparatus used for routine work. Instructions are given for making tests of various kinds for the quantitative determination of ash, sizing and rosin, as well as qualitative tests for the kinds of loading and the various sizing materials. A bibliography is also included giving useful books, periodicals and Government publications on the subject. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

*Cement and Other Building Materials A5-21.* CONCRETE MIXER. A research performed at the Experiment Station of Purdue University on the best conditions for operating concrete mixers in regard to water control and speed. The report includes the strength and consistency of concrete, the time records for various operations, and the measurement of electrical power input. The report is published in the February 1921 issue of the American Concrete Institute. Address A. A. Potter, Director, Engineering Experiment Station, Purdue University, Lafayette, Ind.

*Fuels, Gas, Tar and Coke A5-21.* FUEL RESEARCH. Technical Paper No. 1 on the Assay of Coal for Carbonization Purposes: A New Laboratory Method, by Thomas Gray and James D. King, has been prepared by the Fuel Research Board. This describes the development of a method of coal assay from which the yield can be quickly and accurately determined. Experimental results of the paper explain how the method supplies this information. Price by post, 7d. Address Imperial House, Kingsway, London, W.C. 2.

*Heat A7-21.* HEAT TRANSMISSION. The following papers by Dr. T. S. Taylor deal with work done by the Research Department of the Westinghouse Electric and Manufacturing Company in connection with the study of heat transfer:

A Hot-Wire Anemometer with Thermocouple, Am. Inst. Min. & Met. Engrs., Chicago Meeting, September, 1919.

Thermal Conductivities of Various Insulating and Other Materials, Am. Soc. M. E., New York Meeting, Dec. 2-5, 1919.

The Thermal Conductivity of Coil Wrappers. *Electrical World*, vol. 75, no. 7, Feb. 15, 1920, p. 369.

The Dissipation of Heat by Various Surfaces in Still and Moving Air. Am. Soc. M. E., St. Louis Meeting, May 24-27, 1920.

The Relative Conductor Temperature of Square and Round Insulated Cables, *Electrical World*, March 1920.

The Flow of Air through Small Brass Tubes. Am. Soc. M. E., St. Louis Meeting, May 24-27, 1920.

#### B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

*Air B1-21.* VENTILATION. Tests to determine the amount of air moved under various conditions. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

*Air B2-21.* WINDMILLS. A new type of cam mechanism for use on windmills. University of Texas, Austin, Texas. Address Prof. Hal C. Weaver.

*Apparatus and Instruments B2-21.* Dynamometers. An investigation to develop a method of measuring power by electric means to eliminate the use and construction of expensive dynamometers. Brown University, Mechanical Engineering Department, Providence, R. I. Address Prof. W. H. Kenerson.

*Apparatus and Instruments B3-21.* Fluid Meter. An investigation to develop an automatic liquid volumetric meter. Address Prof. Charles S. Brown, Vanderbilt University, Nashville, Tenn.

*Electric Power B3-21.* Transmission Lines. Trunk transmission lines is the subject of a bulletin in preparation by C. E. Magnusson, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

*Heat B1-21.* Heat Transfer. The Engineering Experiment Station at Pennsylvania State College has been working on the total transmission and conductivity of building materials. In their small "cubical" test box they have recently made special tests on the effect of flowing water on the transmission through concrete and brick. They have recently installed a new testing plate with blanks 2 ft. square over the measured surface. Special attention has been given to the measurement of temperature by thermocouples at various points on the plate and guard ring. Address Engineering Experiment Station, State College, Pa. R. L. Sackett, Dean.

*Heat B2-21.* Heat Transmission. Bulletin 30 of the Engineering Experiment Station of Penna. State College on Heat Transmission through Cork Board and Air Space, by Arthur J. Wood and E. F. Brundhoefer, has been recently issued. The bulletin contains 38 pages of text and a large number of tables, curves and results, with a bibliography of 268 titles on heat transmission. The complete bulletin covers 139 pages. The tests show that conduction and transmission increase in a straight line with increase in temperature difference. The most reliable conductivity for Nonpareil cork board was 8.4 B.t.u. per sq. ft. per 24 hr. for 1 in. of thickness at 90 deg. fahr. difference in temperature. It was also found that the thickness of air spaces affected their insulating value. The experiments showed that the resistance due to multiple air spaces is not proportional to the number of air spaces. Address Prof. A. J. Wood, Pennsylvania State College, State College, Pa.

*Heat B3-21.* Heat Transmission. Investigation relating to the heat transmission through a fiber insulating material known in the trade as "lith" and used in buildings as a heat insulator. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

*Heat B4-21.* Heat Transfer. An investigation to determine the heat-transfer coefficient through various refractory materials. This necessitated the development of a method of measuring temperature for various phases of the steel industry. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

*Heat B5-21.* Steam Radiators. Experiments covering 400 tests on different kinds of radiators and under different conditions have been made at Mason Laboratory, Sheffield Scientific School, Yale University. In connection with these tests the laboratory is coöperating with the Research Bureau of the American Society of Heating and Ventilating Engineers to find a standard method for testing radiators. Address Prof. E. H. Lockwood, Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn.

*Heat B6-21.* Heat. Radiation and Convection from Radiators. An investigation to separate the heat transmitted from steam radiators by radiation and by convection is contemplated at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

*Heat B7-21.* Dissipation of Heat. Dissipation of heat from wires and surfaces of various kinds, including the separation of the parts due to radiation and convection. The dissipation of heat from coils placed in parallel and in series and the effect of spacing. Research Department, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. Address C. E. Skinner, Manager.

*Heat B8-21.* Heat Transmission. The Westinghouse Electric and Manufacturing Company is studying the subject of heat transmission through insulating materials and heat dissipation, which are important in the general study of the ventilation of electrical machines. Although much work has been done and reported (see *Heat A7-21*), much yet remains and the Research Department of the company is studying this question very minutely, giving special attention to the deteriorating effect on insulation. A number of papers have been published by Dr. T. S. Taylor, and a recent paper by Mr. Fetchheimer in the March *Journal A.I.E.E.* is based on the work carried out in the laboratory. Research Department, Westinghouse Electric and Manufacturing Company. Address C. E. Skinner, Manager.

*Heat B9-21.* Pipe Coverings. A bulletin giving the results of exhaustive tests on efficiencies of various kinds and combinations of commercial pipe covering is in preparation by the Engineering Experiment Station, State College of Washington. The tests are being made with equipment built especially for the purpose by which temperatures may be held constant 1/150 deg. by utilizing the expansive quality of hot oil with which the testing machine is filled. The oil-filled space constitutes the bulb of a large thermometer, the stem of which is a glass tube 1/8 in. in diameter.

Temperature measurement is made by a new White potentiometer built for thermocouple work. A study has been made of new methods of applying commercial pipe covering to secure greatest economic efficiency. This promises to be of considerable value.

Curve sheets are being prepared showing relations between temperature, thickness, yearly cost and savings for different kinds and combinations in commercial coverings. Address Dean H. V. Carpenter, Pullman, Wash.

*Heat B10-21.* Heat Transfer to Oil. A study is being made of the transfer of heat from steam to oil through steel pipes. The study is made to determine the heat transfer in warming pipes placed in oil tanks. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

*Heat B11-21.* Heat Transfer Through Glass. A determination of the constant of heat transmission for glass is being investigated at the Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

*Heat B12-21.* The Joule-Thomson Effect in Superheated Steam. The Joule-Thomson effect in superheated steam is being investigated by a candidate for a doctor's degree at Harvard University. The method used is that developed by Trueblood at Harvard some years ago. It is hoped to cover a temperature range to about 600 deg. fahr. and a pressure range up to that corresponding to the saturation pressure of about 600 deg. fahr. Address Prof. Harvey N. Davis, Harvard University, Cambridge, Mass.

*Heat B13-21.* Cryogenic Engineering. The research group in cryogenic engineering at the Harvard Engineering School are working on problems connected with the liquefaction of air for commercial application of fractionating this liquid to obtain pure nitrogen for fixation and pure oxygen for welding and cutting, with the commercial production of helium from natural gas, and the separation of hydrogen from water gas for commercial purposes. Theoretically the oxygen from 1000 cu. ft. of air should be separated by a power consumption of 3 hp-hr. It actually takes from 50 to 75 hp-hr. Work is being done to improve the output. An endeavor is being made to support a non-competitive research by the three larger companies building apparatus for producing liquefied gases. The Research Corporation of New York endowed by Dr. Cottrell has granted certain funds for the prosecution of research work in cryogenic engineering at Harvard. Those doing this work have devised, constructed and perfected apparatus for measuring latent heats at atmospheric pressure and are just finishing this investigation for pure oxygen at the end of the range. The same is true for apparatus for handling coexisting phases up to pressures of 300 to 400 lb. per sq. in., and this apparatus should by this time be in operation on nitrogen-methane mixtures used in the helium problem.

An air-flow meter which will give reliable results at pressures as high as 3000 lb. per sq. in. is now being used. Heat-transfer coefficients and friction heads for high temperatures, low temperatures and high velocities will be determined by this investigation. A tentative temperature-entropy and Mollier chart of air is being prepared. Address Prof. Harvey N. Davis, Harvard University, Cambridge, Mass.

*Hydraulics B1-21.* Flow of Air. A study of the pulsating flow of air is being made for the Flow Meter Committee of the A.S.M.E. by Prof. Horace Judd and Mr. Bucher. Ohio State University, Columbus, Ohio. Address Prof. W. T. Magruder.

*Hydraulics B2-21.* Draft Tubes. A study of the distribution of velocity across draft tubes at different angles and the continuity of flow. Rensselaer Polytechnic Institute, Troy, N. Y. Address Professor Arthur M. Greene, Jr.

*Internal-Combustion Motors B1-21.* New Cycle. The performance of an internal-combustion engine operating on new cycle. Yale University, New Haven, Conn. Address Prof. E. H. Lockwood.

*Internal-Combustion Motors B2-21.* Solid-Injection Oil Engine. The development of a solid-injection fuel-oil engine to determine a correct valve gear and the methods of feeding fuel oil directly into cylinder. An investigation on materials suitable for high-pressure work. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

*Lubrication B1-21.* Oil Grooves in Bearings. A test to determine the effect of oil grooves in bearings under various conditions of load, size of shaft and other details. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

*Machine Design B1-21.* Fillets. An investigation to discover the strength of fillets. Mechanical Engineering Department, Ohio State University, Columbus, Ohio. Address Prof. W. T. Magruder.

*Metallurgy and Metallography B6-21.* Phosphorus and Sulphur in Steel. The Joint Committee on investigation of phosphorus and sulphur in steel has recently made a third statement regarding its work. The Committee on Statistics has supplemented its bibliography on this subject, which is available on application to H. L. Whittemore, Bureau of Standards, Washington, D. C. This committee is anxious to obtain samples of material which have been used under commercial conditions and have given good service or failed in service with ordinary and high sulphur and phosphorus contents. The Committee on Manufacture is making two series of tests: one series covering six grades of material of varying phosphorus and sulphur content, and one series in which the sulphur is added in the later stages of manufacture. Dr. G. K. Burgess is Chairman of this Committee.

The Committee on Tests under the chairmanship of Dr. F. C. Langenberger is making excellent progress on testing rivet bars.

Independent tests are being made at the Watertown Arsenal and the U. S. Experiment Station at Annapolis, as well as at the Bureau of Standards. A committee on Service Tests is being appointed. Address C. L. Warwick, Sec.-Treas., A.S.T.M., 1315 Spruce St., Philadelphia, Pa.

## D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession

of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

*The Barrett Company D1-21.* The Barrett Company has a research laboratory at their Shadyside plant at Edgewater, N. J. This plant is equipped for the physical study of coal tar and for making synthetic chemical investigations. A description of the laboratories and the new laboratory building was given in *Chemical and Metallurgical Engineering* for Jan. 26, 1921. The company is at work on various organic problems and at present the research laboratory has a possible total floor space of 5400 sq. ft. accomodating more than 210 chemists, in addition to those at some of their other plants. Each laboratory in which inflammable organic material is used is provided with two exits and shower bath heads are placed in each laboratory room. Extinguishers are found in each room as well as sand pails and fire hose. The laboratory is also provided to care for large-scale work.

The laboratory is under the charge of a chief chemist and assistant chief chemist and the work is divided into ten divisions, among which are the tar and oil division, organic, research, experimental, plant, engineering and clerical. The Barrett Company, Edgewater, N. J. Address C. R. Downs, Chief Chemist.

*Cutler-Hammer Manufacturing Company D1-21.* The Research Department of the Cutler-Hammer Mfg. Co. is equipped with the usual apparatus for studying the discharge of electricity through gases and machinery of various descriptions and for testing the functioning of controlling apparatus. A supply of direct and alternating current of various voltages and frequencies, a supply of air and gas under pressure and a complete equipment of vacuum pumps, gages and electrical measuring instruments are found in the laboratory. The laboratory is equipped with primary standards for testing all measuring apparatus, and also with a glass-blowing shop and a machine shop for the construction of apparatus. The laboratory investigates physical phenomena relating to the development of electrical controlling apparatus and electrical phenomena in connection with their manufactured products. Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Address Arthur Simon, Engineering Department.

### E—Research Personal Notes

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

*New York University E1-21.* The Department of Mechanical Engineering of New York University is to coöperate in the investigations of the American Society of Heating and Ventilating Engineers. Its laboratory will investigate the question of pipe sizes for steam-carrying capacity and is also planning to do research work on economizers. Address Collins P. Bliss, Professor of Mechanical Engineering, New York University, University Heights, N. Y.

*State College of Washington E1-21.* The Engineering Experiment Station Staff of the State College of Washington at Pullman, Wash., includes Dean H. V. Carpenter as director and fifteen members of the faculty of the College of Engineering, of which one is giving his full time to research.

*University of Utah E1-21.* The Legislature of Utah has appropriated $25,000 for use in metallurgical research in the School of Mines and Engineering, University of Utah. This appropriation covers the expense of research during the last two years. Address J. F. Merrill, Director.

### F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file at the offices of the Society.

*Chemistry, Analytical F1-21.* Water Softening. A bibliography of 13 pages, Search 3305. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

*Fuels, Gas, Tar and Coke F1-21.* Petroleum. History and Properties of Petroleum Fuels. A bibliography of 8 pages. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

*Heat F1-21.* Heat Transmission. A bibliography of 268 titles on heat transmission, prepared by Arthur J. Wood and E. J. Brundhoefer of Pennsylvania State College. Address Prof. A. J. Wood, State College Pa.

*Metallurgy and Metallography F1-21.* Phosphorus and Sulphur in Steel. A bibliography on the action of phosphorus and sulphur in steel has been prepared by the Sub-Committee on Statistics of a Joint Committee investigating this subject. Address H. L. Whittemore, Bureau of Standards, Washington, D. C.

*Steam Power F1-21.* Superheated Steam on Fittings. Effect of Superheated Steam on Steam Pipe and Fittings. A bibliography of 2 pages. Search 3302. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

## THE INTERPRETATION OF BOILER-WATER ANALYSES

(*Continued from page 320*)

5 Determine by titration—
*a* Acidity or
*b* Alkalinity to phenolphthalein
*c* Alkalinity to methyl orange.

6 Calculate from (5)—
*a* Acidity as minus $CO_3$
*b* Alkalinity as plus $CO_3$
*c* Causticity as (OH).

7 Analyze and calculate—
*a* Suspended matter
*b* Total dissolved solids
*c* Loss by ignition (indicate qualitatively if there is any blackening of the residue during heating)
*d* Inorganic dissolved solids
*e* Calcium
*f* Magnesium
*g* Aluminum
*h* Iron and manganese as iron
*i* Silica
*j* Sulphates
*k* Chlorides
*l* Nitrates (nitrometer)
*m* Ammonium (free)
*n* Bicarbonates ($HCO_3$)
*o* Carbonates ($CO_3$)
*p* Hydroxides (OH)
*q* Calculated inorganic dissolved solids [sum of (7-*e*) to (7-*p*), inclusive].

8 When hypothetical combinations are required, calculate as follows and make out a careful balance sheet:
*a* Iron, magnesium and aluminum as sulphates
*b* Calcium as carbonate
*c* Any remaining calcium as sulphate
*d* Any remaining calcium as nitrate
*e* Any remaining calcium as chloride
*f* If any carbonate remains, calculate as much of the available magnesium to carbonate as possible
*g* Any remaining magnesium to sulphate
*h* Any remaining magnesium to nitrate
*i* Any remaining magnesium to chloride
*j* Any remaining anions to corresponding sodium compounds, the value for sodium being assumed
*k* Express silica as such.

9 Apply to (7) and (8) the following criteria:

*a* If the silica exceeds 5 parts per million (p.p.m.) and the causticity 30 p.p.m., report as industrial pollution and discontinue. If silica exceeds 5 p.p.m. and the causticity is low, report as having passed through sanitary filtration for verification.

*b* If the calculated inorganic dissolved solids, (7-*q*) are less than 60 p.p.m. or acidity is indicated under (5-*a*), determine acidity or alkalinity by an electrometric titration and report as (9-*b*).

*c* If the calculated inorganic dissolved solids (7-*q*) lies between the limits 60–300 and the sum of (8-*b*), (8-*c*), and (8-*k*) is less than 60 per cent of this total, or if (7-*k*) exceeds 25 p.p.m. or (7-*l*) exceeds 10 p.p.m., determine a real value of sodium-potassium and report as sodium under (9-*c*).

*d* If the calculated inorganic dissolved solids (7-*q*) exceed 300 p.p.m., discontinue.

*e* If the sum of the calculated inorganic dissolved solids (7-*q*) is less than 60 p.p.m., apply the sanitary analysis which follows.

10 Determine—
*a* Oxygen consumed by permanganate on two samples within the temperature range 60–80 deg. fahr., one at the end of 15 minutes, one at the end of 3 hours.
*b* Nitrites (qualitatively)
*c* Nitrates [transfer (7-*l*)]
*d* Free ammonia
*e* Albuminoid ammonia
*f* Kjeldahl nitrogen.

11 Interpret the limits as follows:
*a* Oxygen consumed: High = 4 p.p.m.; low = 0.6 p.p.m.
*b* Nitrites (qualitatively): High, distinct, faint, very faint trace, none
*c* Free ammonia: High, 1 p.p.m.; low, 0.1 p.p.m.
*d* Albuminoid ammonia: High, 0.2 p.p.m.; low, 0.02 p.p.m.
*e* Nitrates: High, 10 p.p.m.
*f* Chlorides: High, 25 p.p.m.

12 Apply the limits of (11):

| | Free Ammonia | Albuminoid | Chlorine | Inference |
|---|---|---|---|---|
| *a* | High | Moderate | Low | Sewer gas |
| *b* | High | High | High | Sewage |
| *c* | High | Low | High | Human pollution |
| *d* | Moderate | Low | Very low | Vegetable matter |

*e* High oxygen consumed, particularly in the presence of low acidity, is confirmatory of sewage.

*f* If the albuminoid nitrogen is approximately one-half the Kjeldahl nitrogen, it is confirmatory of high organic purity. If it is appreciably greater than one-half, it indicates pollution.

# WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

## A.S.M.E. Locomotive Boiler Code Adopted by Council

An important step in engineering standardization was taken March 23 at the Boston meeting of the Council of The American Society of Mechanical Engineers, when it adopted in its final form that portion of the A.S.M.E. Boiler Code known as the Locomotive Boiler Code. This Code is a noteworthy contribution to the cause of the engineering profession by the eminent engineers who made up the committee. The work of preparation has been long, and the designers and users of locomotive boilers as well as the general public should be sincerely grateful for the Committee's whole-hearted devotion to this work with the consequent heavy sacrifice in time and money.

The necessity for such an addition to the Boiler Code arose from the fact that, while the boilers of locomotives operated on railways engaged in interstate service are covered by the construction and inspection rules of the Interstate Commerce Commission, there was found to be a vast mileage of industrial and short-line railroads in operation in the various states which, by virtue of their location, are not subject to the Interstate requirements. As a result of calls for a Code to cover the construction of boilers of this class, the Sub-Committee on Railway Locomotive Boilers was appointed in 1916. This Committee consisted of F. H. Clark, Chairman, F. J. Cole, A. L. Humphrey, S. F. Jeter, Wm. F. Kiesel, Jr., and H. H. Vaughan. The work of this Sub-Committee was interrupted somewhat by the war, but its preliminary report was submitted to the Boiler Code Committee in April 1919. A month later it was printed and distributed at the Spring Meeting in Detroit, and accepted at the business meeting of the Society. It was thereupon published in the August issue of Mechanical Engineering. The Sub-Committee has been coordinating the points of view of all who would be affected by such a code and the final result approved by the Main Committee and the Council is now ready for use. H. V. Wille and Kenneth Ruchton of the Baldwin Locomotive Works were brought into the Committee, and with F. J. Cole and James Partington, appointed in place of A. L. Humphrey resigned, represented the locomotive manufacturers. Constructive assistance was given by the mechanical division of the American Railway Association through its representatives A. W. Gibbs, mechanical engineer of the Pennsylvania Railroad, W. I. Cantley of the Lehigh Valley Railroad, and N. A. Ferrier of the New York Central Railroad. A. G. Pack, chief mechanical engineer of the Interstate Commerce Commission at Washington, has expressed great interest in the Code, and with his staff of engineers has been in frequent attendance at meetings of the Sub-Committee.

During the past two years Mr. Clark, the original chairman of the Committee, has been in China as technical adviser to the Ministry of Communications at Pekin, and Mr. Vaughan has carried on the work of the Committee as acting chairman.

The new Code deals with the chemical and physical properties of materials of locomotive practice and includes the necessary formulas and methods of construction in detailed specification form for manufacturing safe boilers. Attention is given to the desire of the locomotive builders to maintain the lowest possible weight consistent with strength. As compared with stationary boilers with a safety factor of five, the allowable factor for locomotive shells is four. Requirements in the use of safety valves and their method of test are rigid, as are the hydrostatic tests specified.

The new Code becomes Part I, Section III, of the A.S.M.E. Boiler Code.

Boilers constructed in compliance with the Code may be stamped with the official A.S.M.E. Boiler Code stamp, which is obtainable at the headquarters of the Society.

The stamp will be applied to the dome of the boiler and will be accompanied by name of state, manufacturer's state standard number, name of manufacturer, state's number, year put in service, working pressure when built.

Address all inquiries on this Code to C. W. Obert, Secretary of the Committee, 29 West 39th St., New York, N. Y.

## Boiler Code Interpretations

*The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.*

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 324, 328, 329 (reopened), and 331 to 341 inclusive, as formulated at the meeting of February 3, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

### Case No. 324

*Inquiry:* In the formation of the header element of a water-tube boiler to operate at 500 lb. pressure, with a tubular header 2 in. O. D., is it necessary that the ligaments between tube openings, where 1½-in. cross-tubes are inserted on 1½-in. pitch, shall be designed under the requirements of Par. 192?

*Reply:* It is the opinion of the Committee that while the strength of the construction may be calculated by the ordinary formula for cylinders, there are elements in the particular design which may result in the ability to carry higher pressures than would be allowed by the ordinary formula. The Committee therefore recommends that a test be made as provided for in Par. 247 of the Code. It further recommends that in making the test the pressure that will cause the material to be stressed to the yield point, be determined.

### Case No. 328

*Inquiry:* Is it necessary, in the manufacture of boiler and superheater headers of open-hearth steel pipe, that the tensile strength be calculated on the basis of 55,000 lb., or is steel of lower tensile strength allowable in material of this form as permitted under Par. 28c of the Boiler Plate Steel Specifications?

*Reply:* If the material in the header conforms to a steel specification other than the steel-plate specification and shows a lower tensile strength than 55,000 lb. per sq. in., it is the opinion of the Committee that it is permissible to calculate the header design on the basis of this lower value the same as is permitted for steel-plate material as indicated in Par. 28c. See also Case No. 218.

### Case No. 329 (Reopened)

*Inquiry:* What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing material?

*Reply:* It is the opinion of the Committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in Par. 88 of the Code. While the Code contains no specific statement as to the tensile strength of the material used in seamless tubing, it is the opinion of the Committee that 50,000 lb. could be used as a basis for calculating the safe working pressure.

### Case No. 331

*Inquiry:* Is it permissible, under Par. 311a of the Boiler Code, to use in the blow-off connection a valve and a cock formed in a single body casting, instead of two separate valves or a valve and a cock as specified in that paragraph?

*Reply:* It is the opinion of the Committee that the use of two valves, or a valve and a cock, combined in one body, does not meet the requirements of Par. 311*a* of the Boiler Code.

## Case No. 332

*Inquiry:* Is it permissible under the requirements of the Boiler Code to attach a nozzle outlet to a pipe header manifold by inserting the nozzle through a hole in the header and peening the edges over inside the header, as shown in Fig. 10, the nozzle being autogenously welded to the header on the outside for steam-tightness?

*Reply:* It is the opinion of the Committee that this construction will not meet the requirements of Par. 186, as peening over of the inserted edges of the nozzle will not afford greater strength to withstand the steam pressure on the cross-sectional area of the nozzle than flaring as specified in Case No. 235.

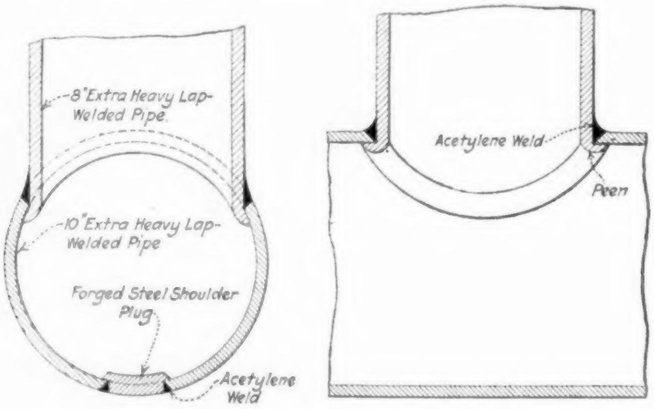



Fig. 10 Proposed Construction of Outlet Nozzle for Pipe Header with Inserted Edges of Nozzle Peened Over

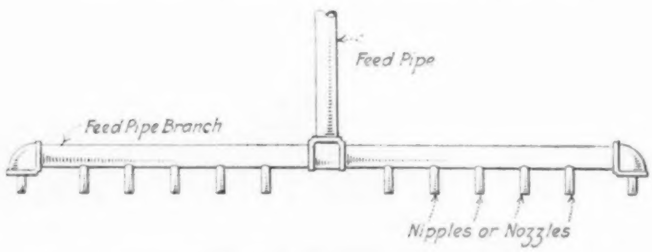



Fig. 13 Proposed Form of Internal Feed Pipe with Short Nipples for Outlets

## Case No. 333

*Inquiry:* (*a*) Where a steam nozzle or safety-valve nozzle is placed upon a boiler drum in which the shell is made thicker than that required for giving a factor of safety of 5, do the requirements of Pars. 260 and 261 apply, which specify that the strength of the reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and the rivet holes for the reinforcement, and that the strength of the rivets in shear on each side of the reinforcement shall equal the tensile strength of the maximum amount of the shell plate removed by the opening?

(*b*) Does Par. 325 respecting allowable shearing and crushing stress on rivets used for attaching lugs or brackets apply to other than h.r.t. boilers for constructions where the weight is more evenly divided between the lugs than in the case of h.r.t. boilers?

*Reply:* (*a*) The requirements in Pars. 260 and 261 are based on the use of a shell having a thickness corresponding to a factor of safety of 5 at the seams, or weakest part of the shell. Where the thickness of the shell is greater than necessary to give a factor of safety of 5, the openings through the shell, to meet the requirements of Pars. 260 and 261, need not be reinforced to any greater amount than that required for such a shell.

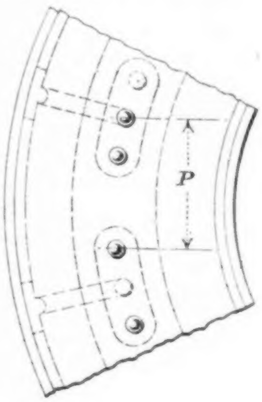
Aside from the requirements in Pars. 260 and 261, the flange of the nozzle should be made substantial enough to withstand cross-strains to which it may be subjected through expansive strains of the piping, etc.

(*b*) Par. 325 applies to all types of boilers irrespective of the number of lugs employed.

## Case No. 334

*Inquiry:* Is it permissible, under the requirements of Par. 332, to apply the A.S.M.E. Code boiler stamp to a boiler whose construction cannot be completed in the shop so as to subject the drum or any of its parts to hydrostatic test? Such a test would only be practical after the boiler has been erected in the field.

*Reply:* It is the opinion of the Committee that those boilers which cannot be completed and hydrostatically tested in the shop may have the stamping applied before shipment, final certification to be made after hydrostatic test is made in the field.



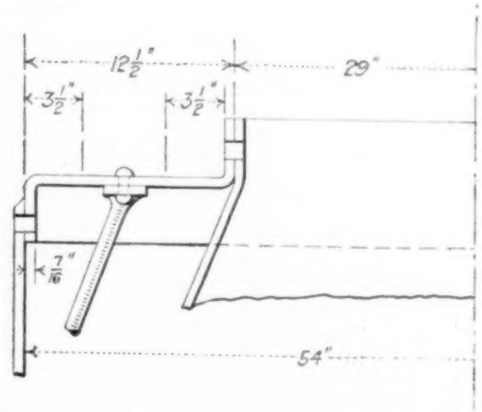




Fig. 14 Bracing of Top Head of Vertical Submerged-Tube Boiler

## Case No. 335

(In the hands of the Committee)

## Case No. 336

*Inquiry:* An interpretation is requested of the term: "or other opening," in Pars. 260 and 261 of the Boiler Code. Does it apply to openings cut for steel nozzles and boiler flanges?

*Reply:* It is the opinion of the Committee that the term, "or other opening," applies to openings cut for steel nozzles and boiler flanges, over 3-in. pipe sizes. (See last sentence of Par. 268)

## Case No. 337

(In the hands of the Committee)

## Case No. 338

*Inquiry:* Is it necessary in the construction of a 54-in. drum of a vertical water-tube boiler, which is formed of $1^3/_{16}$-in. plate with $3^1/_{32}$-in. tube holes, giving a ligament efficiency of 47.3 per cent, to use a butt strap $^7/_8$ in. thick as indicated in Table 1 of the Boiler Code? It is evident that the shell above the ligaments is much stronger than necessary for the desired working pressure

of 225 lb. per sq. in., and that $^{23}/_{32}$ in. thickness of shell is all that is necessary outside of the ligaments.

*Reply:* It is the opinion of the Committee that in the design of a joint for such a drum where the shell thickness is purposely made thicker than necessary for the working pressure in order to increase the ligament efficiency, the butt straps and riveting need not be proportioned for a greater strength than that necessary to carry the working pressure for which the drum is designed.

Case No. 339

*Inquiry:* Will an internal feed pipe formed of a main feed pipe with numerous small short nipples tapped into one side and with elbows at either end bushed down to similar small nipples, as shown in Fig. 13, meet the requirement of Par. 314 of the Boiler Code? This arrangement is made to force a certain amount of water to flow through the nipples instead of all through two nozzles.

*Reply:* It is the opinion of the Committee that the construction proposed does not meet the intent of this requirement, which specifies open ends of the pipe in order that incrustation may not under any circumstances cause stoppage.

Case No. 340

*Inquiry:* Is it permissible under the requirements of the Boiler Code to construct a 66-in. h.r.t. boiler for hot-water heating, to operate at pressures exceeding 50 lb., in which (*a*) handholes only are provided for cleaning and inspection, or (*b*) with manhole below the tubes only and tubes filling the entire upper space of the shell, there being no steam space required?

*Reply:* In the opinion of the Committee, this Case is fully covered by Par. 264, and the construction would be in accordance with the Code if sufficient provision was made for adequate inspection.

Case No. 341

*Inquiry:* What is necessary to determine the pitch of the braces to stay an annulus in the top head of a vertical submerged-tube boiler shown in Fig. 14 in which the annular space is $5^1/_2$ in. wide by 36 in. in inside diameter, and the boiler is to be operated at 100 lb. per sq. in.?

*Reply:* There is no specific rule in the Code applying to such construction. Par. 203*a* indicates the permissible coefficient $C$ for the formula in Par. 199, from which the maximum distance between centers of rivets should be determined. Table 5 gives the permissible stress for braces which, in conjunction with the total pressure on the annulus (making proper allowance for angularity of the braces), designates the total brace area necessary. See also Case No. 308.

# CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

## The Largest Storage Reservoirs of the Western Hemisphere

To the Editor:

In the March issue of Mechanical Engineering, Robert Sibley, in a discussion of Recent Hydraulic Development on the Pacific Coast, stated that the storage reservoir of the Elephant Butte Dam in New Mexico is the largest in the western hemisphere, having a capacity of 2,600,000 acre-feet.

Perhaps Mr. Sibley by a slip of the pen wrote "western hemisphere" instead of "the United States of North America."

The Gatun Dam reservoir holds 4,201,000 acre-feet and the Gouin Dam reservoir at La Contre on the St. Maurice River, P. Q., Canada, 3,673,000 acre-feet. Thus their respective capacities are 62 and 41 per cent greater than that of Elephant Butte Dam reservoir.

C. H. Ellacott.

Tampico, Mexico.

## Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum

To the Editor:

On further investigation of Mr. DeBaufre's paper, I have found that the apparent extreme accuracy of the discharge coefficient to which I called attention in my communication published in the April issue of Mechanical Engineering, was due to the fact that the experimental values were faired up before the table was compiled, and that the great variation from the average of the flow efficiencies given in column 6 of Table 2 actually represented the experimental results, even when the more usual coefficient of discharge was worked out.

I would therefore withdraw my previous remarks and at the same time call attention to the unsuitability of the shaped nozzle, such as was used in these experiments, for standard work. In this set of experiments, which were obviously carried out with great care, and for which the nozzles were obviously made as nearly geometrically similar as possible, the experimental discharge coefficient or flow efficiency varies by about $1^1/_2$ per cent In my own work I always use geometrically similar square-edged orifices for standard measurements, as these are easy to reproduce with accuracy.

I find that such orifices can be reproduced so as to give coefficients of discharge that agree within $^1/_2$ per cent, and that calibration of a small orifice, say, one inch in diameter, can be applied with accuracy (i.e., to within plus or minus $^1/_2$ per cent) to orifices in the neighborhood of 30 in. in diameter.

My own tests on shaped nozzles fully bear out Mr. DeBaufre's results. It is impossible to predict the coefficient of discharge of such a nozzle within 2 or 3 per cent.

John Hodgson.

Luton, England.

## A New Hydraulic Turbine

To the Editor:

A new hydraulic turbine, the invention of Professor Banki of the Polytechnicum in Budapest, has recently attracted considerable attention in continental Europe. Simplicity, high efficiency, high rotating speed and low manufacturing costs are claimed for the new machine.

The principle of the Banki turbine is clearly shown in Fig. 1, where it is seen that the water passes through the blades of the runner *twice*, entering at the left and being discharged radially at the right, and imparting to the runner the greater part of its kinetic energy. The turbine runner is very simple in construction, consisting only of two end disks, a shaft and the blades, which latter are straight cylindrically curved plates with a center angle of about 72 deg.

It is claimed that the Banki turbine is equally efficient at low and high heads, and for low and high speeds, and that the speed and diameter can be selected to suit the requirements without sacrificing efficiency.

All types of Francis and Pelton turbines have a specific speed at which the efficiency is a maximum, and as the runner diameter and speed largely depend upon the quantity of water the turbine has to handle, the designer is restricted in their selection unless he is

willing to sacrifice the efficiency of the turbine. In the Banki turbine, however, the diameter of the runner is independent of the quantity of water passing through the turbine, so that the starting point of the designer can be the most advantageous speed, according to the nature of the drive, and the diameter may be determined to suit this speed.

Professor Banki states that the runner diameter may be obtained from formula: $D = 72.86\sqrt{H}/n$, where $D$ is the diameter of the runner in feet, $H$ the effective head in feet, and $n$ the desired r.p.m.

The fact that the speed is independent of the quantity of water

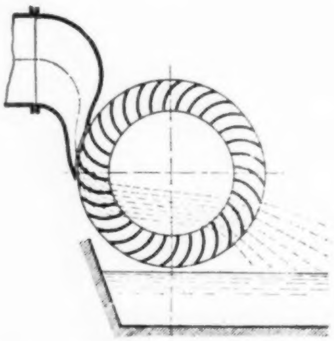


Fig. 1 The Banki Hydraulic Turbine

is of very great advantage in hydroelectric power plants, where the cost of the electric generator decreases almost proportionally with the increase in speed.

The quantity of water determines the width $b$ of the runner, which latter may be obtained from the formula: $b = (0.024$ to $0.03)\ nQ/H$, where $b$ is the width in feet and $Q$ the quantity of water in cubic feet per second.

On account of its construction the setting of the Banki turbine may be very simple. It can be built in as easily as a water wheel and can replace existing water wheels without much change in the setting. It is claimed, moreover, that it is equally efficient at the low heads used until now in connection with water wheels, and at high heads of 500 ft. or more.

Several series of tests have been made in Budapest on Banki turbines of different diameters, under varying heads and different speeds, and efficiencies ranging between 80 and 90 per cent have been obtained, which compare favorably with those shown by other highly developed turbines. M. Burger.

Elmhurst, L. I., N. Y.

## Making Railroad Branch Lines Pay

To the Editor:

Commenting on the paper entitled Feeders for Railroads,[1] in which the author outlines the difficulties with which branch lines have to contend under present conditions and discusses the abandonment of unprofitable lines, practically the only solution of the problem that railroad officials have offered is to "raise the rates."

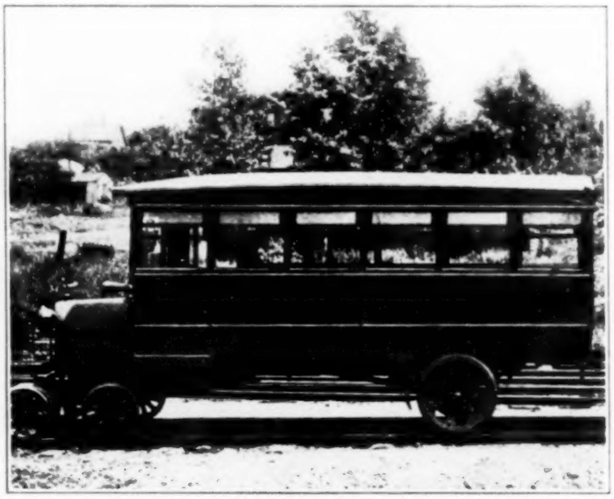
Presumably branch-line operation is unprofitable because of the limited volume of business—this bringing in insufficient returns for wages and maintenance.

Ordinarily the number of freight cars moved and the number of passengers carried may be computed in advance for each branch line. Unless new developments are forthcoming, the number of cars of freight in and out will be practically a constant from year to year; and the one train up one day and back the next that the author speaks of is sufficient to constitute good service. When milk is carried, or to take advantage of terminal facilities, or when more business develops, this becomes one mixed train a day each way. In a more thickly settled territory the demands for better passenger service are met by the addition of other trains, some of them mixed. These trains are a compromise between good service and bad, the public objecting to the slow, inadequate schedule and the railroad objecting to having to furnish service at so obvious a loss.

Mixed-train service is an abomination to passengers—its slow speed and the long waits, together with the infrequent trips, bring down their just wrath upon that intangible thing called "the company." Give these same people more frequent trains on a faster schedule and they will be willing to forego some comfort or pay more for the ride; also they will ride oftener.

To accomplish this, freight and passenger business should be separated as far as train service is concerned. By cutting freight service to not more than one train a day, the interests of all shippers would be served in a most satisfactory manner and at the minimum cost to the railroad. As this would be strictly a freight train, its speed would be slow, making it possible to get along without the heavier rails and other trackwork necessary to heavy trains at high speed.

Now as to passenger service, why try to operate with steam trains? There seems to be no good reason why gasoline cars of three or four tons weight cannot be placed on all branch lines aside from the fact that officials do not want to do this. Railroad men say that such cars are too light, will not stand up under continuous service, have to be repaired all the time, do not have carrying capacity. But these excuses seem ridiculous in view of the facts that locomotives have to be withdrawn at stated intervals for general overhauling (at, say, $4000 a shopping), have to be run monthly to shops for boiler work, are inspected and oiled and have minor repairs made at the end of each run.



Gasoline Car Used for Passenger Service

A gasoline car can make as much speed as any branch passenger train. By the use of more than one car, or of trailers in conjunction with motor cars, a carrying capacity may be maintained to suit the traffic—and the operating expense is always in *direct proportion* to the load. The greatly reduced cost per passenger-mile makes it possible to provide more frequent trains for less money, and frequent service is the one thing that will induce more riding on branches.

Running out of Middletown, N. Y., there are two 15-mile roads—one an independent line and the other a branch of a trunk road. The branch line serves a more populous territory. Each road runs three trains a day each way, two of them mixed. The running time of the branch's mixed trains is an hour and a half, while a good bicycler can beat the passenger trains, pedaling over the automobile road that parallels the rails. The pubiic has objected, as it always does, about slow, infrequent service and mixed trains—why shouldn't they when a gasoline car could shuttle the line continuously at 35 m.p.h. at less cost for the day's work than one steam-train trip? Traffic on this branch line remains about the same year in and year out, but with the public "served" using their autos as much as possible.

The short independent road is progressively managed—and therein may lie the reason for condemning branches generally, i.e., that the management has to do (get along) with the anti-

[1] Presented at the Annual Meeting, December, 1920, of the A.S.M.E. and abstracted in Mechanical Engineering for January, 1921.

quated equipment given them and has to operate a road hundreds of miles away without the advantage of knowing actual needs, such as does one who is always on the ground. Upward of three years ago this independent road decided to try gasoline cars running out of Middletown.

Two cars like the one in the accompanying illustration were put on the road. The winter of 1920 severely taxed even the steam locomotives of all lines and this road maintained such service as it could, which was even more than the traffic warranted. There was no attempt to run the gasoline cars and they were sold to a southern road where they are running today. But as proof of the work of these cars, three more are being fitted up to start running this spring on the line out of Middletown.

The general manager has stated that it cost from 12 to 14 cents a mile to operate the cars, including gasoline and oil, repairs, two men at 40 cents an hour, and depreciation in four years. From this, one can reason that the cars could be junked at the end of four years and new ones bought without incurring any loss!

Moreover, the number of passengers carried while these cars were in service was double that of any previous similar period, which proves that people will ride more when they get service. While the number of steam trains was cut to two each way, there were added five gasoline trains and these latter (only) made stops at four wayside stations, maintaining the same schedule of 15 miles in 35 minutes.

This independent line is also paralleled by a good automobile road and the population, while less than along the branch line named, is distinctly of a better class financially and better able to ride in their own cars. There people knew that they were not being provided with Pullman service—they did not want it—but they knew that they were getting safe and speedy service and at intervals that served their convenience. They took pride in the "buses," as they persisted in calling them.

This was an interesting opportunity to compare two methods of doing the same thing. It is an engineer's comparison. Here are two roads as nearly alike as could be selected. One provides service as it has for forty years—the kind that is unsatisfactory to all concerned—and would abandon the line because receipts have not kept pace with increasing expenses. To abandon such a feeder would mean nothing to the trunk line, for it had a profitable through business.

But the independent road had no through business at all. Its little road constituted its entire stock in trade. To meet increasing costs, unconventional methods were adopted and a leaf borrowed out of the motor-truck book. Business was increased, net revenues increased, and the population turned into boosters. That is engineering.

Donald A. Hampson.

Middletown, N. Y.

## Supplementary Reading for Students in Industrial Management

In the Correspondence Department of the January issue of Mechanical Engineering, Prof. Bruce W. Benedict, director of shop laboratories of the University of Illinois, requested suggestions as to a list of books for supplementary reading by students in industrial management. In a second communication in the February issue, Professor Benedict appended a list used at the University of Illinois and urged again that the subject be discussed through this Department. Communications on this subject have been received from Robert B. Wolf and Walter N. Polokov, consulting engineers, of New York City, and from Hugo Diemer, director of LaSalle Extension University.

Mr. Wolf states that it is just as impossible to solve an industrial problem without a knowledge of the principles which have to do with the development of the individual centers of creation as it is to work in astronomy or mechanics without a knowledge of the laws of gravitation. For students who want to get at the problems of management evolution he suggests a study of evolution in the inorganic world, by taking up geology and by reading

The Origin of the Species, by Darwin.
Creative Evolution, by Bergson.
The Art of Creation, by Carpenter.
The Dore Lectures, by Troward.
Science and Religion, by Keyser.

Mr. Polakov also believes that management deals primarily with men, therefore physiology and psychology should occupy the ranking place in a reading program. He states further that since management of industry aims at production of goods and wealth, a thorough grounding in economics is absolutely essential; and that, dealing with profound human problems, correctness of thinking and breadth of ideas are paramount, hence one must be well versed in mathematics and philosophy. With this end in view he submits the following list, divided into five groups:

*Man:*

Mechanistic Conception of Life, by Loeb.
Heredity and Environment in the Development of Man, by Conklin.
Forced Movements, Tropisms and Animal Conduct, by Loeb.
Psychology, by James.

*Man and Society:*

Capital, by Marx.
An Outline of the History of the Western European Mind, by Robinson.
Vested Interests, by Veblen.
America and the New Epoch, by Steinmetz.

*Philosophy and Mathematics:*

Human Worth of Rigorous Thinking, by Kayser.
Novum Organum, by Bacon.
Human Engineering, by Korzybski (in preparation).

*Managerial Principles and Practice:*

Organizing for Work, Industrial Leadership, and Work, Wages and Profits, by Gantt.
Foremanship, standard course by Y. M. C. A.
Industrial Manager To-day, by Webb.
Principles of Scientific Management, by Taylor.
Twelve Principles of Efficiency, by Emerson.
Mastering Power Production, by Polakov (in preparation).

*Miscellaneous:*

Scientific Management and Labor, by Hoxie.
Industry and Humanity, by King.
Fatigue Study, by Gilbreth.
Fatigue and Efficiency, by Goldmark.
Commercial Economy, etc., in Power Plants, by Smith.
Time Studies and Rate Setting, by Merrick.
Profits, Wages and Prices, by Friday.
The Life and Work of H. L. Gantt, papers of 1920 Annual Meeting, A.S.M.E.

The list presented by Mr. Diemer was recommended by several members of the staff of La Salle and is as follows:

Expense Burden, by Church.
Business Statistics, by Copeland.
Factory Organization and Administration, by Diemer.
Twelve Principles of Efficiency, by Emerson.
Office Management, by Galloway.
Work, Wages and Profits; Industrial Leadership; and Organizing for Work, by Gantt.
Motion Study, by Gilbreth.
Principles of Industrial Engineering, by Going.
Fatigue and Efficiency, by Goldmark.
Human Factor in Works Management, by Hartness.
Administration of Industrial Enterprises, by Jones.
Hiring the Worker, by Kelly.
Principles of Industrial Organization, by Kimball.
Graphic Production Control, by Knoeppel.
Getting the Most Out of Business, by Lewis.
Time Studies as a Basis for Rate Study, by Merrick.
Cost Accounting, by Nicholson and Rohrback.
Applied Methods of Scientific Management, by Parkhurst.
An Approach to Business Problems, by Shaw.
Principles of Scientific Management, and Shop Management, by Taylor.
Scientific Management, by Thompson.
Purchasing, by Twyfort.

It is hoped that other discussion and other lists will be forthcoming, from which a "Three-Foot Shelf of Books" may be made up and kept on file at the headquarters of the Society.

# MECHANICAL ENGINEERING

**A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of**

**The American Society of Mechanical Engineers**

**29 West 39th Street, New York**

Edwin S. Carman, *President*

William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* Ralph E. Flanders

George J. Foran Alex. G. Christie

John T. Wilkin

PUBLICATION STAFF:

Lester G. French, *Editor and Manager*

Frederick Lask, *Advertising Manager*

*Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.*

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.


## Character and Knowledge in Engineering

Raymond Walters

Qualities of character as the prime factor in engineering success were stressed in the Carnegie Foundation report of 1915 in which were presented the opinions of 7000 engineers, all members of the four national engineering societies. In 94.5 per cent of the replies to a questionnaire sent these engineers the character group of qualities—character, judgment, efficiency, understanding of men—received a total percentage rating of 75, while knowledge of fundamentals and technique were rated at 25 per cent.

Good-scholarship in collegiate days as a mark of the eminent engineer is revealed in a recent study made under the auspices of the American Association of Collegiate Registrars, in which facts about the scholastic training of a group of distinguished engineers are given.

It is of interest to note at the outset that the criterion of eminence employed in this new study is the selection by the four national engineering societies of their officers and important committee members and representatives over a period of five years. This arbitrary criterion is of course not perfect. It leaves out success which is independent of professional activity and recognition, and tends somewhat to emphasize scientific and ethical aspects. However, reasonable limitation is a gain. Highly successful engineers outside of the societies are likely to be remiss in the obligation which Roosevelt once declared every man owes to the upbuilding of his profession. The scientific and ethical aspects are those which most profit the nation.

The most optimistic believer in the interrelation between good scholarship in college and good work in later life would hardly have ventured so high an estimate as the facts show the correspondence to be for the group of eminent engineers investigated. The facts are, that of the 392 collegiate graduates listed as eminent by the Registrars' Association and who represented the four national engineering societies,

182, or 46.4 per cent, stood in the highest fifth of their classes upon graduation;

109, or 27.8 per cent, stood in the second highest fifth of their classes upon graduation;

72, or 18.3 per cent, stood in the middle fifth;

14, or 3.6 per cent, stood in the next to lowest fifth;

15, or 3.8 per cent, stood in the lowest fifth;

The figures for the A.S.M.E. representatives in the "eminent" list are of particular interest to the readers of Mechanical Engineering. Of the 117 representatives of this Society, 54, or 46.1 per cent, were in the highest scholastic fifth; 30, or 25.6 per cent, were in the second highest fifth; 24 or 20.5 per cent, were in the middle fifth; 5, or 4.3 per cent, were in the second lowest fifth; and 4, or 3.4 per cent, were in the lowest fifth.

It was found that for five engineering schools which furnished more than half of the engineering graduates in the "eminent" list, the proportions were different as to the upper scholastic fifths. The second highest fifth led. The middle fifth more nearly approached the two higher fifths. The two low scholastic fifths had the same low percentage as in the total grouping.

The forty-seven other engineering schools which furnished 163 representatives and the twenty-three colleges having forty bachelor-of-arts representatives on the engineers' "eminent" list had exceptionally large percentages in the two highest scholastic fifths and small percentages in the low scholastic fifths.

Included in the Collegiate Registrars' study was an analysis of the scholastic training of all of the 730 eminent engineers embraced in the list. This disclosed that 580, or 79.5 per cent, were college graduates; 35, or 4.8 per cent, were college non-graduates; 115, or 15.8 per cent, had secondary-school training only. The student who starts and does not finish his collegiate course is shown in a particularly unpromising light.

Satisfactory returns could not be obtained covering the extra-scholastic activities of the eminent engineers in their college days—athletics, literary and engineering activities and social activities. No safe generalizations can be drawn. The one service the figures perform is, by contrast, to stress how definite and uniform for all groups considered is the correspondence between good scholastic work and good professional work.

Is there a contradiction between the Carnegie Foundation report of popular engineering opinion and the Registrars' Association findings as to scholastic standings? It does seem, from the Collegiate Registrars' facts, that popular opinion is overenthusiastic in its three-to-one proportion in favor of character qualities over knowledge of fundamentals and technique. This opinion might have been distinctly different had those who expressed it been aware of the very high scholarship records of the men they and their fellow-members have in the past elected to professional society leadership.

Aside from modification of overemphasis upon qualities of character, the Registrars' Association study does not contradict the Carnegie Foundation report. It combines with the latter in significant fashion. Taken together, the vote emphasizing personal qualities in engineering leaders and the study attesting the intellectual powers of engineering leaders (as shown by scholarship rank and later achievement) furnish an instance of the positive correlation between intellect and character which Prof. E. L. Thorndike, of Columbia, once expressed thus: "The brains and ability of the world have been, and still are, working for the profit of others."

For students in engineering colleges and for young engineers there are striking lessons in the results of these investigations.

Young men should beware of the notion that the student who does poor work or mediocre work has as good a chance for later eminence as the good student. Not *opinion*, but *facts*, explode this myth.

In the attainment of engineering success, as of all other success, time and chance, as a very old book tells us, cannot be entirely ignored. But luck is no persistent factor. The elements that tell in the long run are knowledge and character and the habit of action. The lesson for youth is a fresh emphasis upon these elements and upon the development of them in the one sure way—the efficient, whole-souled doing of each day's work.

Raymond Walters.[1]

[1] Registrar, Lehigh University, Bethlehem, Pa.; Secretary, American Association of Collegiate Registrars.

## Lubrication and Hot Bearings

FROM time immemorial the bugbear of mechanics has been hot bearings. Most of us were brought up to fear heat in the bearings of machinery, and most of us have spent a good part of our lives in struggling to obtain a bearing and conditions that would allow that bearing to work without any heat at all.

Inspired by a paper on Practical Lubrication,[1] by Lieut. G. S. Bryan, U. S. N., I conducted some experiments with a pair of journals running in half-boxes with the upper side of the journal all exposed. A recess on the leading side of the journal was made in the box to receive oil and the corner was rounded to induce oil to run between the journal and the box. This recess was filled with a heavy oil. When the journal was revolved very slowly, nearly all the oil in the recess rolled under the journal and remained upon its surface. As the speed of the journal was increased oil was left in the recess, until at a speed of a thousand feet per minute of the journal nearly all of that oil was scraped off from the journal into the recess. Even at this speed there was sufficient oil left on the journal so that it did not abrade the metal. The temperature was so high that it would burn the flesh when the fingers were touched to the surrounding metal. Still that journal continued to run for a long time until the experiment was considered to be complete.

This heavy oil was then thoroughly cleaned from the journal and the boxes and kerosene oil put in its place. The spindle was revolved slowly and the kerosene oil left the recess and deposited itself on the journal. As the journal was gradually speeded up to a thousand feet per minute, the kerosene oil still appeared to remain on the journal; none was deposited in the recess and the journal revolved practically cold through quite a long period. While the heat from the first experiment with thick oil came very quickly, the kerosene-oil experiment was run for a considerable time, without excessive heating.

When an ordinary machine oil was placed in the recess and the journal revolved slowly, that oil all ran under the journal and seemed to remain on its surface. As this speed was gradually increased up to a thousand feet per minute, a portion of this machine oil was scraped off the journal and remained in the recess. Some heating was developed, but not enough to burn the flesh. This experiment was allowed to run through the same period of time as the others, but the heat did not increase above the original point, which was just where it was uncomfortable to the fingers held on the iron around it.

This oil was then removed and a so-called universal spindle oil was put in the same place. All of this oil left the recess at whatever speed the journal revolved and seemed to remain on the journal running continually between the journal and the box. So little heat was developed that it was just barely warm, regardless of the length of time it ran.

These experiments seem to show that Lieutenant Bryan is right when he says:

> The first effect of a high temperature in a bearing, then, is to thin the oil and thus decrease the friction. The effect of cooling the bearing is to increase the friction. There is no virtue in keeping a bearing at a very low temperature by the use of a considerable amount of cooling water, and there is no reason why a bearing should not be allowed to run at a high temperature as long as it is in good condition and is getting plenty of good, clean oil.

He further tells of one case of an average temperature of 205 deg. fahr. that was maintained for thirty days; and also of bearings which run regularly at temperatures of 190 deg. and 210 deg. that never cause any trouble.

Another thing that these experiments seemed to prove was that oil grooves in bearings are of no value. In most cases they are injurious, in that they reduce the bearing surfaces by just that amount. They also seemed to prove that instead of using graphite and various kinds of heavy oils when heat troubles arise, the best thing to do is to use a thin oil. This applies, of course, to high-speed bearings where the bearing is of sufficient area to sustain the load on the oil.

A further point brought out by these experiments—also brought out by Lieutenant Bryan—is that with oil constantly running on a bearing the oil can be exceedingly thin, because what is forced out by the load is constantly replaced by new oil and the bearing surfaces never come together.

But my thought in connection with this is that we have been deceived into a state of fear because there is heat in a journal. Any journal that will revolve long enough without abrasion to allow us to manifest this fear and worry, I consider to be perfectly safe.

Thousands of dollars are wasted every week in this country by the fact that mechanics stand and discuss and worry, and that engineers, superintendents and managers write letters, send telegrams and hold up the production in their works because the bearings of a machine are hot; and it is all useless fear.

C. H. Norton.

[1] *Journal of American Society of Naval Engineers*, vol. xxvii, No. 4, November, 1915.

## Lester G. French

As the May issue of Mechanical Engineering is being released for printing, word has been received of the death of Lester Gray French, on April 18, at the French Hospital in the city of New York. For the past thirteen years Mr. French has been editor and assistant secretary of The American Society of Mechanical Engineers, which organization he has faithfully and ably served throughout that period, developing the publications of the Society to a very high standard.

Mr. French was born in Keene, N. H., in April 1869. He received his technical education at the Massachusetts Institute of Technology, from which he was graduated in 1891 with the degree of S.B. Since 1897 Mr. French has been associated with technical publications; in that year he became editor-in-chief of *Machinery*, continuing in this position until 1906, when he resigned to take up the publication of technical books, among them being one of the earliest American treatises on the steam turbine, of which he was the author.

A more detailed account of Mr. French's professional career will appear in the June issue of Mechanical Engineering.

## Americans to Greet British Engineers

There is a very deep sense of gratitude on the part of the engineering societies of the United States for the part played by the engineers of Great Britain in the war.

The inability of Sir Robert Hadfield to come to the United States to receive the John Fritz medal developed the idea in the minds of the trustees of the John Fritz Medal Board of Award that the occasion of presenting this medal in England might be made the opportunity for expressing greetings by the engineers of the United States to the engineers of Great Britain.

The idea has been worked out and a deputation will be sent to the summer meeting of the Institute of Civil Engineers. This deputation will consist of a delegate from each of the four societies represented on the John Fritz Medal Board of Award. Dr. Hollis will accompany the deputation and carry the message from the American engineers. The delegates that have been selected are Charles T. Main, representing the American Society of Civil Engineers, Col. Arthur S. Dwight, representing the American Institute of Mining and Metallurgical Engineers, Ambrose Swasey, representing the John Fritz Medal Board of Award and The American Society of Mechanical Engineers, and Dr. F. B. Jewett, representing the American Institute of Electrical Engineers.

## Digging Panama Canals Underground by Hand

IN his various addresses upon the subject of industrial waste, Herbert Hoover has repeatedly referred to the bituminous-coal industry as one of our worst-functioning industries. "These mines," he said at the Syracuse meeting of the American Engineering Council, "operate seasonally and erratically. They proceed from gluts to famines, from profiteering to bankruptcy."

This seasonal operation means for the miner less than 200 days'

employment each year; and what is of even greater import, he does not know from week to week when he will have work to do, nor how much work there will be.

For this condition the mining industry is not wholly to blame. Coöperation by the railroads and large consumers of coal are necessary if a more regular output is to be secured; and to accomplish this some governmental or other central agency is urgently needed as a directing force.

Coupled with this bad economic functioning is the friction and strife between the coal operators and the miners, and more particularly the miners' union, The United Mine Workers of America, as told in the almost daily dispatches from the coal fields of West Virginia. Apparently, the situation is a deadlock, with intolerable conditions existing, for the relief of which no constructive policy has yet been proposed by the mine owners.

In this connection, and as a comment on the present status of the coal-mining industry, our attention has been directed to a paper presented before the American Economic Association by Arthur J. Mason, of Chicago, in which he contends that the present unsatisfactory conditions could be greatly alleviated by abolishing the arduous (and probably useless) labor of shoveling the coal by hand into the mine cars after the face has been shot in the mine. He would introduce machines for loading the coal, which, while primarily a mechanical problem with apparently little bearing on the general economic situation, he believes would have a most important psychological effect on the whole industry.

Mr. Mason is an ore engineer and approaches coal mining as an outsider, influenced more by the accomplishments in his own field than by the habits and precedents of the coal-mining industry. He has lived through the period of the remarkable development of the mechanisms for the handling of ore with which engineers are familiar and sees the possibility of an equally useful development in coal mining.

He gives the rather startling figures that 1,000,000 men in the United States pass their working lives down in the mine or near the pit mouth, and as part of their work shovel each year nearly 700,000,000 tons of coal into railroad cars from its resting place in the mine. "It is," he states, "as though we were to go back to spading our land in agriculture instead of plowing it."

How much coal is 700,000,000 tons? According to Dr. Mason's calculations, the coal mined in the months of January and February alone would fill the whole Panama Canal; and according to figures given out at the time the Canal was completed, the actual excavation for the Canal was about one-third the volume of coal now mined in this country each year!

The relation which mechanical loading might be expected to have to the general mining operation may be thus briefly summarized:

For each 1,000 tons brought up from the mine, 100 acres is provided below as a labyrinth of entries, rooms, tracks, switches, ventilation devices, so that in a big mine, raising 5,000 tons, almost a section a mile square is so organized—a bewildering city underground. This area largely arises from the pseudo-ownership which every miner acquires of his room or rooms, technically known as his "place."

In a coal mine, like any tunnel, the work will proceed with the frequency with which a face is shot. In Southern Illinois faces are shot about once in four days. If faces were shot every day, it would follow that the area to be kept alive, with all the agencies mentioned, would be correspondingly reduced. Two and one-half acres would become the equal of 10 acres, and the cost of mining over what is paid the so-called miner (about twice the miner's wages) would be reduced accordingly.

Machine loading would necessarily abolish the institution of "places" in coal mining. A group of six men with a loading machine and motor should average 100 tons of coal per hour loaded in mine cars, the crew passing from room to room.

In spite of the large economic waste in the coal industry in various directions, Mr. Mason believes that the greatest waste is in manhood. Hours needlessly spent in a mine is not what men most desire. "Can one conceive," he says, "a proposal more splendid than to bring to the surface and the light of day thousands of men to do some finer and better work, and to bring upward with them their families and dependents?"

## Submarine Against Submarine

In his entertaining book, The Victory at Sea, Rear-Admiral Sims gives what to many will be a new conception of the efficacy of the submarine in hunting and destroying the submarine during the war. The belief is general that the most successful hunter of the submarine was the destroyer, and so far as absolute figures are concerned this is true. Destroyers, with their depth charges and gun fire, sank more U-boats than any other agency; but relatively the submarine itself proved a more destructive enemy of the submarine than did the destroyer.

The Allied destroyers, about 500 in number, sank 34 German submarines; auxiliary patrol craft, such as trawlers, yachts, etc., about 3000 in number, sank 31; while the Allied submarines, only 100 in number, sank 20. It is therefore evident that the latter surpassed in their effectiveness the most formidable of the surface anti-submarine vessels.

Admiral Sims regards this work of the Allied submarines as in a way the most astonishing development of the naval operations of the war. "It is particularly interesting," he says, "because from that day in history when the submarine made its first appearance the one quality which seemed to distinguish it from all other kinds of warship was that it could not be used to fight itself." It was supposed to be a vessel valuable almost exclusively to the weaker sea powers. It could destroy battleships and cruisers, but not vessels of its own kind, and for that reason has not been popular with nations having strong navies. Early in 1800 Robert Fulton endeavored unsuccessfully to sell to England the inventions incorporated in his submarine *Nautilus*. St. Vincent, then First Lord of the Admiralty, refused, saying, "Why encourage a kind of warfare useless to those who are masters of the sea and which, if successful, will deprive them of this supremacy?"

In connection with the recent war, Admiral Sims says it is important that we keep in mind the fact that the submarine is only occasionally a submarine; and that for the greater part of its career it is a surface boat. In the long journeys which the German U-boats made to the hunting grounds which lay in the Atlantic trade routes, they traveled practically all the time on the surface of the water. The ability to submerge was merely a quality which was utilized only in those crises when the submarine either had to escape a vessel which was stronger than itself, or planned to attack one which was weaker.

The simple fact that the submarine can accomplish its destructive work only when submerged, and that it can avoid its enemy only by diving, makes it plain that it must always hold itself in readiness to submerge at a moment's notice and remain under water the longest possible time. Its storage batteries, therefore, must not be wasted by needless under-water travel—in other words, it must spend all its time on the surface where it can be propelled by its Diesel engine, except during those brief periods when it is attempting to attack a ship or escape an enemy.

The situation with the Allied submarines, however, was quite different. The Allied submarine commander did not have to maintain such constant readiness to submerge and to remain submerged, for there were not German surface vessels operating on the high seas and he had no enemies to fear. The British and American fleets were attending to that. For this reason he was not compelled to economize his electric power so strictly and he could, in fact, spend a considerable part of his time under water. This gave him a great advantage in hunting U-boats, for he could cruise around all day at slow speed, with only the periscope of his submarine showing. "Just as the German U-boat could 'spot' an Allied destroyer at a great distance without being itself seen," says Admiral Sims, "so could the periscope of the Allied boat spot the German submarine on the surface long before this tiny object came within the view of the U-boat conning tower. Our submarine commander could remain submerged, sweep the ocean with his periscope until he picked up the German enemy; then, still under water, and almost invariably unseen, he could steal up to a position within range and discharge a torpedo into its fragile side The German submarine received that same treatment which it was itself administering to harmless merchantmen; it was torpedoed without warning; but, as it was itself a belligerent vessel the proceeding violated no principle of international law."

# Industrial Relations and the Engineer

## Basic Principles Presented at Joint Meeting of New York Section of A.I.E.E. and Metropolitan Section of A.S.M.E.

"WHEN the mariner has been tossed for many days in thick weather and on an unknown sea, he naturally avails himself of the first pause in the storm, the earliest glance of the sun, to take his latitude and ascertain how far the elements have driven him from his true course. Let us imitate this prudence and before we float further, refer to the point from which we departed that we may at least be able to conjecture where we are now."

This quotation from Daniel Webster's speech against Hayne—made by Dr. Ira N. Hollis with particular reference to the present status of industrial relations—expressed the purpose of the joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers on March 25. The program included dispassionate statements of the conditions on which correct industrial relations must depend and emphasized the necessity for analytical considerations of these conditions by engineers.

In his opening remarks, the chairman of the meeting, Walter Rautenstrauch, vice-president of the J. G. White Management Corporation and professor of mechanical engineering at Columbia University, emphasized the importance of the fundamental principles upon which permanent industrial relations should be based. He outlined these as: (1) The need for relationship between employer and employee, which is well founded economically; (2) the establishment of principles relative to the obligations of the parties involved as well as their rights; (3) a foundation of justice; (4) the organization of both parties for work, emphasizing production and service rather than organization for the acquisition of something.

The first speaker of the evening was Dr. F. H. Giddings, professor of sociology at Columbia University, who presented the social background of the problem of industrial relations. Professor Giddings made a distinction between the social background and the economic foreground. Economic questions enter into all disputes between organized labor and organized capital. A sound judgment of industrial relations rests equally, however, on an understanding of the social phases which relate to life itself, for the support and amelioration of which wealth is the means. He stressed as important the fact that the fundamental trouble with capitalism is that it is not capitalistic enough, in that wealth is not being used productively but is being wasted or even immorally squandered. The sensitive spot is not found in the distribution of wealth, therefore, but in the reactions of present-day industrial relations upon the wage earner himself. Men develop full lives not only through creative work but through relations with fellowmen as members of society. Through membership in numerous organizations and as citizens, opportunity for usefulness, happiness and self-expression are found. Therefore, quite normally, wage-earning groups desire a larger opportunity to share in the organization and control of things industrial. This desire is recognized in the present talk on industrial democracy. In closing, Professor Giddings emphasized the importance of a careful consideration of all the factors and the bringing forth of a solution by unprejudiced people. He outlined the place the engineer should have in bringing forth this solution on the basis of an intellectual rather than an emotional approach to the problems to be solved.

The address by Doctor Hollis, which will be printed more fully in a future issue of MECHANICAL ENGINEERING, developed the rise of the industrial worker coincident with the development of mechanical power. In it he analyzed the true measure of the rise of the industrial worker, in increase in numbers, increase in power of organized workers, gain in wealth, increase in opportunity and the development of a satisfaction through work for others, and dwelt on this last item almost entirely. He measured the rise of any human effort or agency by its tendency to minister to the satisfactions of life. No gain in numbers, power or wealth that does not accomplish this is a permanent gain.

Dr. S. M. Lindsay, professor of social legislation at Columbia University, related the recent enactments of state legislatures affecting industrial relations. He outlined the steps taken to protect women and child workers, compulsory safety enactments, and the laws passed to establish arbitration in industrial conflict.

Bringing up to date a paper delivered before the Spring Meeting of The American Society of Mechanical Engineers in 1919, L. P. Alford, editor of *Management Engineering*, presented the recent developments in organizing personal relationships in industry. Mr. Alford's previous paper reviewed the major lines of development of the 35 years preceding 1919.

Under the heading of Profit-Sharing Plans, Mr. Alford differentiated true profit sharing from allied schemes such as stock subscriptions, wage bonuses, saving methods, etc., and presented the conclusions of the National Industrial Conference Board Report of an analysis of 41 experiences of profit sharing, as follows: (1) From experience with profit sharing in the past with plans now in operation, profit sharing has been successful for limited periods; (2) judging by the long list of abandoned plans, and the comparatively small number that have endured more than a few years, the effectiveness of profit sharing in surviving the many vicissitudes of an industrial enterprise is decidedly uncertain; (3) in the light of the high percentage of abandonments due to dissatisfaction among the workers, it is reasonable to conclude that wise and efficient management plays a very important part in the success of profit-sharing plans.

Considering Methods of Wage Payment, two tendencies during the past two years were noted: (1) To pay an addition to earnings based upon an established wage-payment system; and (2) to return to piece-rate payments during the past few months.

Under Methods and Laws to Reduce Hazards in Industry, Mr. Alford reviewed the enactments in the various states. Progress was indicated by the reduction in accidental deaths from 35,000 in 1912 to 22,000 in 1919. In contrast the deaths on American highways have increased from 35,000 in 1912 to 100,000 in 1920.

Employment management made rapid strides in 1919 and 1920. At the present time with unemployment in industry estimated at 4,000,000 workers, employment departments are being disbanded or curtailed in proportion to reductions of working forces. Present conditions are leading to a study of the economic justification of employment work that will bring about a more substantial basis for the employment and personnel functions in the future.

Mr. Alford listed the declared rights of labor recognized by the proclamation creating the National War Labor Board which were written into the Versailles Peace Treaty. There have been no new developments in this regard in the past two years because of lack of Senate action concerning the Peace Treaty.

In his consideration of the Mutual and Joint Control Methods, he referred to the report of President Wilson's Second Industrial Conference in December 1919, and to the developments leading to the establishment of the Kansas Industrial Court.

In closing, Mr. Alford emphasized the engineering character of recent attempts in organizing human relationships in industry and pointed out the important responsibilities of the engineer in organizing and treating human activities on the same basis of knowledge as prevailing in the more technical aspects of the engineer's work.

The final paper of the evening was presented by Mr. A. L. De Leeuw, consulting engineer, who gave a critical analysis of the human tendencies that must be recognized in industrial relations. Working from the premise that the engineer must know the properties of the materials with which he builds, Mr. DeLeeuw outlined the situations brought about in industry by the two outstanding human tendencies, or sets of qualities, with which we have to reckon—the individualistic and the social. The necessity for leadership was expressed and the importance of well-informed, well-balanced labor leaders was emphasized. In closing, Mr. De Leeuw stated the need for some form of definite understanding between employee and employer by which the product and compensation are properly fixed and their relative relation maintained.

# A.S.M.E. to Meet in Chicago May 23-26

## Preceded by Trip to McCook Field and Followed by Excursion to Rock Island, Chicago Program Has Diversity, Interest and Value

THE 1921 Spring Meeting of The American Society of Mechanical Engineers bids fair to be the most popular of any of the recent Spring Meetings. The excursions to McCook Field and Rock Island Arsenal offer interesting opportunities which, coupled with the main sessions at Chicago, will attract the mechanical engineers of the entire country.

#### Excursion to McCook Field

The membership is afforded a fine opportunity to become acquainted with the nerve center of aeronautic development in this country. On Saturday, May 21, the Aeronautic Division, jointly with the S.A.E., is to visit McCook Field, Dayton. The morning is to be spent in an inspection of the shops and experimental laboratories, looking over the latest designs in aeroplanes and motors, parachutes, radio apparatus, cameras, etc. After lunch, to be served at the cafeteria, there will be a flying program. The evening will be spent at the Engineers' Club, when the gathering will be addressed by some of the leaders in aeronautic development.

#### Rock Island Excursion

Following the meeting at Chicago, two days—May 27-28—will be spent at Rock Island Arsenal with the Army Ordnance Association. The Ordnance Division will present an interesting program, and an inspection of the plant will be made. The visit to the Arsenal is limited to citizens of the United States who are not engaged in the manufacture of munitions for foreign governments. Saturday the 28th will be given over to a golf tournament to be held on the Rock Island links.

### The Chicago Meeting

The four days, May 23-26, to be spent in Chicago are planned to include a remarkable collection of valuable professional sessions, attractive entertainment and interesting plant visits. The Professional Divisions have coöperated with the Committee on Meetings and Program to provide the strongest program possible. In so far as is practical, the plants to be visited have been selected with the idea of supplementing the technical program.

Chicago itself, the fourth largest city in the world, with its stock yards, its immense terminals, its remarkable schemes for municipal development, its wonderful educational institutions, and its fine parks, is well worth a visit, even without the attraction of the Spring Meeting. This virile metropolis—the center of a large number of A.S.M.E. members who are earnestly planning for the comfort of their guests—will undoubtedly attract the largest number thus far assembled at a spring gathering of mechanical engineers.

The tentative program given on the following page presents a great diversity of interest and is worthy of careful study.

#### Chicago Session

In accord with past practice, a session will be devoted to the consideration of the vital problems pertaining to the section of the country adjacent to the Spring Meeting city. The Chicago transportation problem has been selected as a subject of commanding interest, not only locally but nationally. In this session the Western Society of Engineers is coöperating, and its Terminal Committee has arranged a program touching on the problems of Chicago as a Mid-Interior Rail-Water Gateway. This program is valuable to all engineers in that it gives insight into the magnitude and complications of one of the earth's greatest railroad centers. Various phases of this subject will be presented by J. R. Bibbins, consulting engineer, Dept. of Transportation and Communication, Chamber of Commerce, Washington, D. C.; E. J. Noonan, engineer of the Chicago Terminal Commission; Hugh E. Young, engineer of the Chicago Planning Commission; and Bion J. Arnold, consulting engineer, of Chicago.

#### Industrial Education and Training

Realizing the growing need for development in education and training in the industries, an evening session has been assigned for a powerful presentation of this subject. The Committee on Training for Industries plans to have able speakers give their experience in developing successful schemes of training in the various industries, and with the important points brought out hopes to develop considerable activity in the future educational work of the Society. The fact that a recent Congressional Committee reported that the United States had fallen from first place to seventh in its educational standing among the nations, has emphasized the vital need of a careful consideration of this subject by the engineering profession.

#### Business Session

The important topic for discussion at the business session will be the extended changes planned in the Constitution and By-Laws.

#### Power Test Codes Hearing

Three codes will be presented for discussion and adoption during the Spring Meeting. These Codes are those dealing respectively with Reciprocating Steam Engines, Evaporating Apparatus, and General Instructions.

### Sessions of Professional Divisions

#### Forest Products

At the Spring Meeting the Forest Products Division plans to complete its organization and will present three papers on phases of the development of engineering in the utilization of forest products.

#### Fuel

The general topic of the Fuel Session is the utilization of Mid-Western Fuel, and, as indicated on the program, the presentation will be made by men who have had broad experience in this field. An excursion to the successful pulverized-coal-burning plant of the Milwaukee Electric Railway and Light Company is planned in connection with this session.

#### Machine Shop

The Machine Shop Division is to discuss the development in machine tools and machine-shop practice brought about by the automobile industry, which has increased the sizes of machine-tool units, developed new requirements in accuracy, and revolutionized methods of manufacture.

#### Management

An interesting paper on the Organization of an Engineering Society, by Morris L. Cooke, will be presented at the Business Session. Its discussion, however, will be carried on during the Management Session, inasmuch as this paper was procured through the Management Division. It is also planned to receive the preliminary report of the Committee on Terminology which has been appointed jointly by the Taylor Society, the Society of Industrial Engineers, National Association of Cost Accountants, Industrial Relations Association of America, and the American Institute of Accountants. This committee has been working for several months on the preparation of a dictionary of terms used in management engineering, and the adoption and use of these terms will do much to clarify management literature and assist in the development of the art of management. L. W. Wallace will present an account of the work of the American Engineering Council Committee on the Elimination of Waste.

#### Materials Handling

The application of material-handling machinery to road building has been adopted by this Division for its Spring Meeting topic. The country needs better and cheaper highways, and the province of the mechanical engineer in providing machinery to satisfy these needs is well defined. This session should therefore be of great

interest not only to the designers of road-building machinery, but to the users as well. Motion pictures of modern road-building machinery will be shown.

### Power

The Power Division is to coöperate with the Chicago Section of the A.I.E.E. and the mechanical and electrical sections of the Western Society of Engineers to provide the program for this session. The general subject will be Power Resources of the Middle West, and two strong papers will be presented.

### Railroads

The Design of Large Freight Locomotives is the general subject selected for the Railroad Session. The three papers provided on this subject will furnish the basis for an interesting discussion of the needs and problems of the motive-power departments of the railroads.

### General Papers

Five valuable papers will be presented at the two General Sessions. Mr. White's paper on the hydraucone regainer gives the history of the development of this device which has proved valuable in increasing the effectiveness of hydroelectric installations. Mr. Johnston's paper presents the results of a number of tests of oxy-acetylene welding and cutting blowpipes. These tests were made by the Bureau of Standards for the War Department shortly

*(Continued on page 356)*

# TENTATIVE SPRING MEETING PROGRAM

## Chicago May 23–26, Headquarters at Congress Hotel

*(Other subjects or changes to be announced later)*

**Monday Afternoon, May 23**

Business Meeting: Discussion of Changes in Constitution and By-Laws
On the Organization of an Engineering Society, M. L. Cooke

**Monday Evening, May 23**

Reception and Dance at Congress Hotel

**Tuesday Morning, May 24 (Simultaneous Sessions)**

FUEL SESSION

- Recording Ash-Pit Loss from Chain-Grate Stokers, E. G. Bailey
- Boiler Tests with Pulverized Coal, Henry Kreisinger and John Blizard
- Limitations of Mechanical Stokers Utilizing Mid-West Coals, E. H. Tenney
- Capacity and Efficiency Limitations of Stokers Using Mid-West Coals, John E. Wilson
- Discussion of Smoke Problem with Reference to the Health of the Community, Dr. John D. Robertson
- Latest Requirements of the City of Chicago in Furnace Design, with Special Reference to Hand-Fired Boilers and Limits of Each Design, Frank Chambers

MACHINE-SHOP SESSION

- Influence of the Automobile on Gear Cutting and Gear-Cutting Machinery, H. J. Eberhardt
- Influence on Power Presses, Dies and Special Tools as a Result of the Demands of the Automobile Industry, Henry J. Hinde
- Lathe Design, R. E. Flanders
- Interchangeable Manufacture, C. B. Lord

MANAGEMENT SESSION

- Industrial Waste, L. W. Wallace
- Report of Committee on Management Terminology
- On the Organization of an Engineering Society, (Discussion) M. L. Cooke

GENERAL SESSION

- Capacity Tests of Dry-Vacuum Pumps, by the Low-Pressure Nozzle, S. B. Redfield
- Report on Efficiency Tests of a 30,000-kw. Steam Turbine, H. B. Reynolds

**Tuesday Afternoon, May 24**

Excursions

**Tuesday Evening, May 24**

Session on Training for the Industries

**Wednesday Morning, May 25 (Simultaneous Sessions)**

CHICAGO SESSION

- Some Aspects of the Problem of Chicago as the Mid-Interior Rail-Water Gateway, J. R. Bibbins
- Development of Air Rights in Connection with City Freight Houses, E. J. Noonan
- Freight Movement by Motor Trucks, Wiewpoint of Carrier and Public, Hugh E. Young
- Freight-Tunnel System as a Terminal Distribution Agency, J. R. Bibbins and E. J. Noonan
- The Function of the Terminal Survey, J. R. Bibbins
- The Relation of Steam Roads to Rapid-Transit Development, Bion J. Arnold

GENERAL SESSION

- Investigation of Oxy-Acetylene Welding and Cutting Blowpipes, R. S. Johnston
- Interpretation of Boiler-Water Analyses, J. R. McDermet
- The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants, W. M. White

PUBLIC HEARING ON POWER TEST CODES

This Session will be devoted to the discussion of the proposed Power Test Codes on General Instructions, Reciprocating Steam Engines, and Evaporating Apparatus.

**Wednesday Afternoon, May 25**

Excursions

**Wednesday Evening, May 25**

Dance at Congress Hotel

**Thursday Morning, May 26 (Simultaneous Sessions)**

RAILROAD SESSION

- Design of Large Locomotives, M. H. Haig
- The Needs for the 2-10-2 and Other Heavy Freight Locomotives for Road Service, A. F. Stuebing
- Necessity for Improvement in Design and Operation of Present-Day Locomotives, H. W. Snyder

MATERIALS HANDLING SESSION

- Planning and Organizing a Road Job for the Mechanical Handling of Material, C. D. Curtis
- Road-Construction Plants, B. H. Piepmeier
- The Mechanical Side of Highway Construction, R. C. Marshall, Jr.

FOREST PRODUCTS SESSION

- Woodworking Education, Dean Moon

POWER SESSION

- Power Resources of the Middle West. (Authors to be announced later)

**Thursday Afternoon, May 26**

Excursions and Moving Pictures

# Secretary Hoover Resigns from Presidency of F.A.E.S.

## Executive Board of American Engineering Council Meets at Philadelphia—New Member Societies—L. W. Wallace Representative on U. S. Board of Surveys and Maps

AN important meeting of the Executive Board of the American Engineering Council of the F.A.E.S. was held at the Engineers' Club of Philadelphia on April 16. The closing action of the session was the acceptance of Herbert Hoover's resignation as president of the Council. As a member of the Executive Branch of the Government Mr. Hoover felt that he could not consistently direct the activities of an organization which is engaged in furthering national activities involving legislation. In a resolution of regret at Mr. Hoover's retirement the Board voted its appreciation of his leadership during the organization period of the Council and his initiation of policies and effort.

In regard to the question of Government reorganization, it was voted to renew the activities of the National Public Works Department Association for the establishment of a National Department of Public Works. Committees of the Association in every state will coöperate with the Smoot-Reavis Committee of Congress in a movement to reorganize the Department of the Interior by placing the public-works functions of the Government under central control. The Council will also support the Smoot-Reavis Committee in its program for the revision of the governmental machinery to promote economy and efficiency in departmental administration.

A progress report of the Committee on the Elimination of Waste in Industry said that a series of intensive assays of more than 100 industrial plants has been completed, and that the field workers have made their reports. These reports are being collated and will be made public sometime in June.

Following the meeting of the Executive Board, a dinner, attended by 600 engineers, was given at the Bellevue-Stratford Hotel by the Engineers' Club of Philadelphia and its fourteen affiliated societies, comprising a membership of more than 4600 in Philadelphia and Eastern Pennsylvania. The presiding officer was Guilliaem Aertsen of the Midvale Steel & Ordnance Company and president of the Engineers' Club of Philadelphia. The toastmaster was Major Joseph A. Steinmetz, past-president of the Engineers' Club and chairman of the Aeronautic Division of the A.S.M.E. Mr. Aertsen, as president of the Club, presented Herbert Hoover, president of the F.A.E.S., with a certificate of honorary membership in the Engineers' Club of Philadelphia. Following the presentation Mr. Hoover delivered an address on the Reorganization of Government Departments.

Other speakers were Dean Dexter S. Kimball of Cornell University, vice-president of the F.A.E.S., whose subject was The Federated American Engineering Societies; J. C. Trautwine, Jr., editor of Trautwine's Hand Book, whose topic was The Engineers of Philadelphia, and George W. Pepper, lawyer and publicist. A summary of Mr. Hoover's address follows:

One problem of the new administration that has received the attention and thought of the organized engineers of America for many years is that of the reorganization of the Federal Government. To any student of Federal organization, one sweeping and fundamental necessity stands out above all others,—that the administrative units of the Government must be regrouped so as to give each of the great departments more nearly a single purpose. Such functions as public domain, public works, assistance to veterans, public-health functions, aids to navigation, to industry, to trade, purchasing of major supplies, are each and every one scattered over from four to eight departments, most of which are devoted to some other major purpose.

Economies can be accomplished from a public point of view by an elimination of the overlap in these different units of administration through unification into groups of similar purpose. The real economy to the nation, however, does not lie here, however great this may be, but it lies in their more effective functioning in their daily relation to the public.

As a result of the war the responsibilities for the major purposes of the Treasury, War and Navy Departments have been enormously increased. In the interests of efficiency they should not be called to responsibility for the administration of matters not pertinent to their major functions.

There is also some confusion between executive, advisory, and semi-judicial functions. One of the tendencies of government, both local and national, during the last twenty years, has been to add executive functions to commissions and boards created primarily for advisory or regulatory purposes. Executive functions cannot rise to high efficiency in the hands of Government boards in which each member has a separate responsibility to the public and is primarily engaged in a semi-judicial function.

Furthermore, during the last few years there has been a great growth of independent agencies in the Government reporting directly to the President, until his office is overburdened almost beyond the point of endurance, and coördination with executive departments is rendered extremely difficult. It is neither possible nor advisable to place all these outside organizations within the departments, but much could be done to mitigate the situation.

The economic changes in the world, growing out of the war, and their reflex upon our trade and industry make it vital, if we are to maintain our standards of living against increasing ferocity of competition, that we shall concentrate and enlarge our national effort in the aid, protection, stimulation and perfection of our industrial and commercial life.

We want no paternalism in government. We do need in government aids to business in a collective sense. In a department we do not want to either engage in business or to regulate business. We need a department that can give prompt and accurate diagnosis from both a foreign and domestic point of view of economic events, of economic tendencies and of economic ills; that can promptly and accurately survey economic opportunity, economic discrimination and opposition; that can give scientific advice and assistance and stability to industry in furnishing it with prompt and accurate data upon production, supplies and consumption; that can coöperate with it in finding standards and simplifications; that can by broad study promote national conservation in industry and the elimination of waste; that can study and ventilate the commercial side of our power possibilities; that can study and advise national policies in development of rail, water, and overseas transportation; that in fact covers, so far as government functions can cover, the broad commercial problems of trade, industry, and transportation. This can be accomplished more by coördination of existing governmental facilities than by increased expenditures.

## Three More Societies Join F.A.E.S.

The membership of The Federated American Engineering Societies has been increased in recent weeks by The Boston Society of Civil Engineers, the Milwaukee Engineering Society and the Duluth Engineers' Club. There are a number of other societies which will probably become affiliated with the F.A.E.S. before July 1, at which time the opportunity of coming in as a Charter Member will expire. At present the membership of the Federation includes 24 engineering societies and clubs, including a total membership of nearly 50,000 engineers.

## Council Appoints Representative on U. S. Board of Surveys and Maps

The American Engineering Council's Committee on Procedure has appointed L. W. Wallace, executive secretary of the Council, as its representative on the United States Board of Surveys and Maps. Mr. Wallace succeeds Alfred D. Flinn, secretary of Engineering Foundation, and has been assigned to the Committee on Coöperation.

The Federal Power Commission, Army Air Service, and Naval Aviation have been added to the membership of the Board and committees have been reorganized so as to better distribute the work. The Advisory Council of the Board has asked the American Engineering Council to assist in obtaining an adequate program involving a larger appropriation for topographic maps.

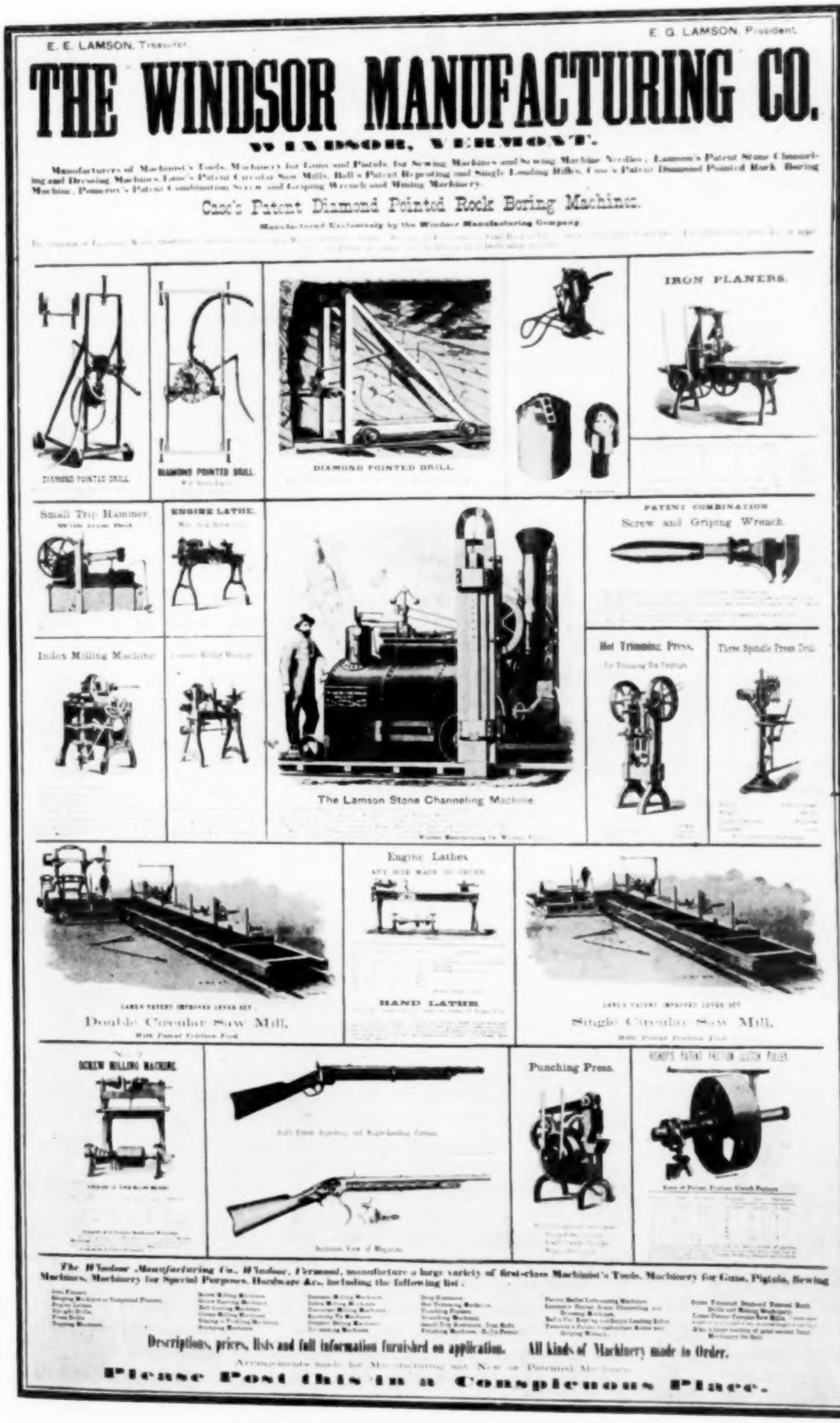
## F.A.E.S. Establishes Permanent Headquarters in Washington

Permanent headquarters of the F.A.E.S. have been established at 719 Fifteenth Street, N. W., Washington, D. C., with L. W. Wallace, secretary of the Federation, in charge. In addition to office accommodations for the staff of the Federation, sufficient space has been obtained to provide a conference room for those who may desire to use headquarters for a meeting place. It will be the purpose of headquarters at all times to render as much personal service as possible for engineers who visit Washington, enabling them to transact business matters with the minimum amount of effort on their part. The new office will continue the services rendered by M. O. Leighton and A. C. Oliphant in the Washington office of Engineering Council.

## History of Machine Industries of Windsor, Vt., Now in Preparation

There are certain localities, particularly in New England, where mechanics of early days did pioneer work of strikingly original character and which have had a marked influence upon the development of the machine industry of the entire country. One of these is Windsor, Vermont, and it is gratifying to learn that a complete history of the rather surprising mechanical accomplishments of that place is being prepared by Mr. Guy Hubbard of the Engineering Department of The National Acme Company of Windsor. Since in the ninety-two years of their existence companies which are either descended from or related to the Windsor concerns, men who learned their trades there, and things manufactured there, have become widely scattered, valuable information relating to this history has often been found available from very unsuspected sources. Further information would be greatly appreciated by Mr. Hubbard and full credit given for whatever is used.

Among the more important things which have been either originated or developed to a practical state in Windsor are the rotary gear pump, the Lincoln-type milling machine, the turret lathe, breech-loading and repeating small arms, and automatic screw machines. Among the famous mechanics who have a place in the history of these developments are James Hartness, Governor of Vermont, and the late Charles E. Billings, who are both Past-Presidents of The American Society of Mechanical Engineers.




Poster Issued in 1865 Showing Diversified Product of One of the Old Machine Firms of New England (Reproduced from a Distorted Photograph)

The line of machine industries at Windsor, which has continued unbroken down to the present time, was founded in 1829 as The National Hydraulic Company, builders of Hubbard's patent rotary pumps, which are still manufactured, practically unchanged, by The Fales & Jenks Machine Company of Pawtucket, R. I., who purchased the patent rights at Windsor in 1833. In 1830 The National Hydraulic Company built and installed the 20-hp. pump of the first water works of St. Louis, Mo. They later went into the manufacture of Kendall's patent underlock rifles, becoming in 1844 Robbins, Kendall & Lawrence, and in 1849 The Robbins & Lawrence Company (1849–1858). This was one of the most famous gun and machine-tool concerns of its time and did much to spread the interchangeable system both in this country and abroad. In 1854 and 1855 they built most of the machinery for the Royal Armory at Enfield, England.

The Robbins & Lawrence Company, through successive changes, under Mr. E. G. Lamson became The Windsor Manufacturing Company (1865–1869), which was succeeded by The Jones and Lamson Company. In 1888, following Mr. Hartness' identification with this company, it was moved to Springfield, Vt., and became The Jones and Lamson Machine Company, the manufacturers of the Hartness flat turret lathe. The Windsor Machine Company then took over the old shops at Windsor, where the Gridley automatic screw machine was developed, a machine original in its conception like its noteworthy predecessors. In 1915 this company became a part of The National Acme Company, being known as its New England Plant.

One of the many interesting documents which Mr. Hubbard has unearthed in the course of his researches is a poster, reproduced on this page, which was issued in 1865 by the Windsor Manufacturing Company and constituted a catalog of their products. This poster is a striking illustration of the diversity of output which machinery manufacturers attempted before the days of specialization, and is of particular interest because of the remark-

able character of the machines illustrated. There is shown a reasonably complete line of machine tools and metal-working machines, including a Lincoln miller and an indexing milling machine. In those day every town with water power had its sawmill, a requirement met by this company. Stone-channeling machines and air-driven diamond-pointed rock drills were produced primarily to meet the needs of the marble quarries of Vermont. And, finally, a magazine rifle was manufactured which is said to have done very effective service in some of the closing battles of the Civil War, and which was certainly in marked contrast to the muzzle-loading arms used to a large extent throughout that war.

## American Railway Engineering Association

Annual convention in Chicago, March 15, 16 and 17. The rail committee, in their report, expressed surprise at the attitude of the mills toward the rail specifications adopted by the association in 1920. The mills refuse to roll rails of any weight under a contract requiring full compliance with the 1920 specifications and will roll according to modified specifications only if large extras are paid. The committee will determine during the coming year whether it is best to adopt two specifications, one without running into extra price and the other requiring an extra price, or to accept only one specification without extra cost over the manufacturer's base price, the association to be given a list of specific refinements in the order of their importance so that roads requiring a higher grade of rail will have the benefit of the association's judgment on the most valuable of such refinements. M. H. Wickhorst discussed the relation of shattered steel in fissured rails to the mill end of the rail. C. W. Gennet, Jr., explained how unsafe rails can generally be traced to unsound ingots. A new cut track spike specification was adopted by the association on the recommendation of the committe on track. A new bolt specification was also adopted. Bolts, other than heat-treated, must be of mild-carbon steel with a tensile strength of not less than 50,000 lb. per sq. in. and an elongation of not less than 15 per cent in 8 in. Heat-treated or high-tensile bolts must be of carbon or alloy steel and conform to the following minimum requirements: Tensile strength, 100,000 lb. per sq. in.; yield point, 70,000 lb. per sq. in.; elongation in 2 in., 15 per cent; reduction of area, 40 per cent.

## Brief History of Engineering Council

At the final meeting of the Engineering Council held at Washington in December 1920, a committee consisting of J. Parke Channing, Philip N. Moore and Alfred D. Flinn was appointed to prepare a brief history of the activities of the Council from the time of its establishment in the spring of 1917 to its termination in December 1920. The Committee states that the report, which is now completed, is not a full record of the Council's activities but is rather a summary of examples indicating the variety of subjects handled and the methods of dealing with them. Through the instrumentality of Engineering Council, notable progress has been made in organizing the engineers of the country for service not only to the members of the profession, but also to national, state and local governments and the public, in matters of general interest in which the technical training and experience of engineers should be utilized. The work so well inaugurated will be carried on by the American Engineering Council of The Federated American Engineering Societies.

## An Opportunity for Young Engineers

The attention of young engineers residing in Greater New York is called to the formation of a Tank Corps within the National Guard of the State of New York. The Eighth Coast Command Armory located in the Bronx has been designated as the home of the new organization. Recruiting is done at the office of L. K. Davis, ex-major, Tank Corps, A.E.F., 347 Lexington Ave., New York City, every Monday night between eight and ten, and at the Armory on Thursday nights.

The tank corps is a branch of the service essentially an engineering problem. It requires a diversified knowledge embraced in the activities of the engineering societies, and it is hoped that junior members of the various engineering societies may be interested in this Tank Corps.

## A.S.M.E. TO MEET IN CHICAGO MAY 23–26

*(Continued from page 353)*

after the armistice. Mr. Redfield's paper presents a simple and effective method for making capacity tests with dry-vacuum pumps. Mr. McDermet's paper on boiler-water analysis throws new light on this old subject. The tests on the 30,000-kw. steam turbine reported by Mr. Reynolds in his paper present valuable data of tests of large units which are not generally available.

### Hotels

It is anticipated that the hotels in Chicago will be crowded during the week of the Spring Meeting. To assist the membership in securing hotel reservations, a double card was sent out with the Spring Meeting circular. One half of the card is to be sent to the hotel and the other half to the Chicago Hotel Committee, who will keep in touch with the hotels and make sure that the member's request for reservation is given prompt and careful attention by the hotel. The Chicago Hotel Committee has no responsibility to engage rooms for the members, however, its sole duty being to secure the necessary action by the hotel.

### Special Railroad Rates

Arrangements have been made with all railroad lines, except those in the Southeastern and Canadian Passenger Associations, by which members may obtain a considerable reduction in their railroad fares. When buying a ticket to Chicago ask your agent for a special rate certificate. Upon presentation at Chicago a half-fare rate home may be obtained, provided the return is over the same route used to go to Chicago. This special rate applies only if 350 certificates are presented, but as it applies to all rates over 67 cents, every member is requested to ask for a certificate so that those coming from long distances may be assured of the reduction.

## ON THE ORGANIZATION OF AN ENGINEERING SOCIETY

*(Continued from page 325)*

Engineering Societies or otherwise, regular assemblies of engineers of all varieties should be held where subjects common to all can be discussed and plans for the public welfare developed in which the entire body of engineers can have a part.

It is not good engineering to drift to a result. We do not do it in our professional work. We decide what we want to do and then we do it, and usually pretty well within the time set. The time element is usually as easily determined as the design. It is something of the same spirit that we must get into our group activities. We must seek to formulate the community's problems and then cope with them as we do with the narrower problems of our everyday practice. No scheme of engineering organization will be satisfactory which does not include the broadest possible coöperation with other organized groups—professional, industrial, commercial, and social. Coöperation is of the very essence of the future. Our thought should be centered on the avoidance of any limits in our plans for coöperation.

In conclusion, it may be said that if in our organized activities we make efficient service our watchword and have uncompromising publicity as a day-to-day policy, we will provide a type of leadership which the people will follow. The old disciplines are largely gone. It is up to the technologists—"the profession of creation and construction, of stimulation of human effort and accomplishment,"[1] to erect those standards of effectiveness and aspiration to which a race may rally.

[1] Principles of Mining, Herbert Hoover.

# Engineering and Industrial Standardization

## Standard Power Test Codes

ALL who have occasion to test power-plant apparatus will be interested in knowing that the large A.S.M.E. committee which has for some time been revising the Power Test Codes of 1915 will hold its first public hearing on May 25 at the Congress Hotel, Chicago. This public hearing will constitute one of the sessions of the Spring Meeting of The American Society of Mechanical Engineers.

The three Codes which will be presented for discussion and adoption at this hearing are those on Reciprocating Steam Engines, Evaporating Apparatus, and General Instructions. Those who are not able to go to Chicago are urged to send in written criticism and discussion. A pamphlet containing reprints of these Codes in their present form will be supplied on application to the A.S.M.E. Committee on Power Test Codes.

## Removable Lighting Fixtures

Recognizing the growing demand for removable electric lighting fixtures for domestic use, the New York Section of the Illuminating Engineering Society devoted its January meeting to a full discussion of the subject. The papers presented and the discussion which followed their presentation bore more or less directly on the proposal that standard ceiling and bracket fixtures be so equipped with plug connections that any layman can put up or take down any fixture at will.

So much interest was aroused at this meeting that the Council of the Illuminating Engineering Society has since considered the possibilities of this proposal and has adopted a resolution urging all concerned to coöperate to the fullest extent in bringing about complete interchangeability of removable lighting fixtures. The resolution lays particular stress on the standardization of the electric attachments and other devices in the early stages of this development.

## Standard Tables for Refrigerants

Intimately connected with the work of the A.S.M.E. Committee on a Standard Tonnage Basis for Refrigeration, is the suggestion of its chairman, F. E. Matthews, that the tables which record the physical properties of the various refrigerants be standardized as to the data given and the form and the arrangement of the tables.

Engineers now have available a number of tables giving the physical properties of the saturated vapors of water, ammonia, carbon dioxide, sulphur dioxide, methyl chloride, ethyl chloride, and other media which have been employed or proposed as refrigerants. No two of these tables, it is thought, include exactly the same kind of data arranged in the same order under any uniform system of captions and symbols.

The United States Bureau of Standards is now formulating a table of the properties of ammonia in the saturated and superheated regions. The table covering the saturated region has already been submitted in a tentative form to the American Society of Refrigerating Engineers. Since it is through the direct efforts of that society that funds are being provided for the work of making the final observations and computations necessary to complete these ammonia tables, it may be assumed that the tables will be presented in the form that will be most convenient for the use of refrigerating engineers, provided such form can be determined in advance. The present time, therefore, seems most propitious to invite suggestions from engineers and others in an effort to arrive at the most practical form.

To precipitate discussion on this subject we print below a list of ten column headings which are suggested for the proposed standard tables of physical properties of vapors. The tentative report of the Bureau of Standards referred to, which was printed in the January 18 issue of *Power*, contains ten columns of data. Of the headings listed below, columns 1, 3, 7, 4, 5, 6, 9, and 10 are there employed in the order indicated. In addition to these the Bureau of Standards' table records the Specific Volume of Liquid and the Entropy of Vaporization. It omits, however, Gage Pressure (col. 2) and Weight of Liquid (col. 8).

1 Temperature, deg. fahr. ($t$)
2 Gage Pressure, lb. per sq. in. (?)
3 Absolute Pressure, lb. per sq. in. ($P_1$)
4 Total Heat of Liquid above (—) 40 deg. fahr. and deg. cent., B.t.u. ($q'$)
5 Latent Heat of Vaporization, B.t.u. ($r$)
6 Total Heat of Vapor above (—) 40 deg. fahr. and deg. cent., B.t.u. ($i$)
7 Specific Volume of Vapor, cu. ft. per lb. ($V''$)
8 Weight of Liquid, lb. per cu. ft. (?)
9 Entropy—Liquid ($s'$)
10 Entropy—Vapor (?)

The general confusion existing regarding symbols for these quantities is a matter which should also be cleared up if possible at this time. If the symbols adopted could be international standards the results would be well worth striving for. To that end the widest publicity and freest comment are hoped for.

It is probable that differences of opinion will be expressed concerning the inclusion of columns 2, 3, 9 and 10 in a table designed for the convenient use of the operating refrigerating engineer. The questions which naturally arise can be stated as follows:

1 Are all ten columns listed necessary for a handy working table?
2 What substitutions or additions should be made?
3 Should Gage Pressure (column 2) be included?
4 Should the two Entropy columns be retained?
5 What standard symbols should be employed for the quantities listed?

Answers to these questions and written discussion covering other points to be considered in the development of standard tables of physical properties of refrigerants will be given careful attention if addressed the A.S.M.E. Secretary of Standards and Technical Committees.

## Automobile Headlighting Specifications Submitted for Approval

The Illuminating Engineering Society has submitted its Automobile Headlighting Specifications to the American Engineering Standards Committee for approval. These specifications are submitted in accordance with the special provision in the procedure of the Committee, under which important standards in existence prior to 1920 may be approved without going through the regular process followed in new work.

The specifications have been adopted in their essential details by the states of Wisconsin, Connecticut and Maryland, and by the Province of Ontario, and have been endorsed by the Standards Committee of the Society of Automotive Engineers; by the International Traffic Officers' Association, and by the conference committee on Uniform Vehicle Laws, representing some 30 different organizations, under the auspices of the National Safety Council.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of these specifications, and to receive any other information regarding the specifications in meeting the needs of the industry.

The Headlighting Specifications of the Illuminating Engineering Society may be found in the Transactions of the Society, Vol. XV, No. 4, June 10, 1920. Copies may also be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York.

---

At a meeting in London on April 25, of the executive secretaries of the standards associations of the principle commercial countries of the world, Dr. Paul G. Agnew, Secretary of the American Engineering Standards Committee, represented this country. His plans include visits to Belgium, France, Sweden, Switzerland, and Czecho-Slovakia to exchange general information on standardization projects, and to establish more intimate relationship with the standardization bodies of these countries.

# LIBRARY NOTES AND BOOK REVIEWS

Belts for Power Transmission. By W. G. Dunkley. Sir Isaac Pitman & Sons, Ltd. (Pitman's technical primer series). Boards, 4 x 7 in., 104 pp., diagram, 7 x 4 in., boards, $1.

This is a small volume, for students and designers, presenting and discussing the factors and considerations involved in belt driving. Tables of use to designers are included.

The Boiler Book. Compiled by H. E. Dart. Published by the Hartford Steam Boiler Inspection and Insurance Co., Hartford, 1920. Paper, 7 × 10 in., 65 pp., 20 illus., $1.50.

This book, which is a novel and useful addition to the published works on boiler practice, is a collection of formulas, data and general information of great value to all having to do with the design, installation, operation and maintenance of steam boilers of all kinds. In accordance with the established practice of the Hartford Steam Boiler Inspection and Insurance Co., all drawings, tables and other data included are in full accordance with the provisions of the A.S.M.E. Boiler Code. The book is published in loose-leaf form and contains a copious index. The illustrations are in the form of blueprints.

Compressed Air. By Theodore Simons. Second edition. McGraw Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 173 pp., illus., tables, $2.

This treatise is intended to give the student such an insight into the natural laws and physical principles underlying the production, transmission and use of compressed air, as will enable him to comprehend the operation of the various appliances used for this purpose and to judge of their merit. The present edition has been carefully revised and partly rewritten.

Copper Refining. By Lawrence Addicks. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 211 pp., illus., tables, $3.

Electrolytic copper refining was for so many years conducted under conditions of strict commercial secrecy that but little has been published regarding the principles of operation, as distinct from descriptions of individual plants. This little book, comprising a series of articles, each dealing with one of the problems of refining, which originally appeared in *Chemical and Metallurgical Engineering*, is almost entirely a record of the author's personal experience.

The Dynamics of the Airplane. By Kenneth P. Williams. John Wiley & Sons., Inc, New York, 1921. (Mathematical monographs, 21.) Cloth, 6 × 9 in., 138 pp., diagrams, $2.50.

This book, intended for students of mathematics and physics who are attracted by the dynamical aspect of aviation, grew out of a course of lectures on aerodynamics given by Professor Marchis, at the University of Paris in 1919. The treatment is elementary for the most part.

Electric Welding. By Ethan Viall. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 417 pp., illus., $4.

This volume is a compilation of the available literature on electric welding, selected and arranged by an experienced editor. It forms a convenient source of information on present methods, apparatus and applications.

Elements of Fuel-Oil and Steam Engineering. By Robert Sibley and C. H. Delany. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 466 pp., illus., tables, $5.

The theme of this book is a study of fuel-oil power-plant operation and the use of evaporative tests to increase their efficiency. It includes an exposition of the elementary laws of steam engineering, the use of oil for fuel in the modern power plant, and the testing of oil-fired boilers. This edition has been rewritten, and much new material added.

Employee Training. By John Van Liew Morris. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 8 in., 311 pp., $3.

This work presents the results of an inquiry into the program and organization machinery being utilized by various manufacturing concerns to train their own workers, both by apprenticeship courses and by vocational training. It shows industry's own solution of its training problems and should be suggestive to manufacturers as a collection of tried methods.

Hendricks' Commercial Register of the United States. Twenty-ninth annual edition (1921). S. E. Hendricks Co., Inc., New York, 1921. Cloth, 8 × 10 in., 2572 pp., $12.50.

This well-known classified directory of manufacturers and dealers in supplies used by engineering firms has been carefully revised, new firms have been added, and those no longer extant have been eliminated. As in previous issues, the directory includes a classified list of dealers, an alphabetical list, an index of trade names, and an index of commodities.

Installing Management in Woodworking Plants. By Carle M. Bigelow. The Engineering Magazine Co., New York, 1920. Cloth, 6 × 9 in., 323 pp., illus., $5.00.

The author's purpose has been twofold; first, to express in a general way his ideas as to the application of the principles of scientific management to an industry, and second, to outline in detail their application to the specific problems of the woodworking industry.

Kinematics and Kinetics of Machinery; a Text Book for Colleges and Technical Schools. By John A. Dent and Arthur C. Harper. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 383 pp., illus., tables, $3.50.

This treatise gives systematic methods, mainly graphical, of determining velocities, accelerations and inertia forces which can be applied to practically all mechanisms. The text is based upon notes prepared by Professors G. A. Goodenough and F. B. Seeley, and used for instruction at the University of Illinois. These notes have been revised and extended by the authors.

The Locomotive Up to Date. By Chas. McShane. Revised by author. Griffin & Winters, Chicago, 1920. Cloth, 6 × 9 in., 893 pp., illus., plates, $5.

The first edition of this book appeared over twenty years ago, and found popularity as a clear explanation of the construction, operation and repair of the locomotive, suited to the needs of railway men without special engineering knowledge. The present edition has been revised, enlarged, and partly rewritten, to meet modern conditions.

The Manufacture of Pulp and Paper. Vol. 1. Arithmetic, Elementary Applied Mathematics, How to Read Drawings, Elements of Physics. By J. J. Clark. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 132 pp., illus, $5.00.

This book is the first of a series of five volumes, prepared under the auspices of the Canadian Pulp and Paper Association and the Technical Association of the Pulp and Paper Industry, which is intended to form a suitable course of study in the fundamentals of mathematics and science and the manufacturing operations involved in modern pulp and paper practice. The treatment is simple, as the books are intended for self-instruction, as well as for classroom use.

Marine Engineering. By A. E. Tompkins. Fifth edition, revised. Macmillan and Co., Ltd., London, 1921. Cloth, 6 × 9 in., 888 pp., illus., $11.25.

An extensive one-volume textbook covering a sound course in marine engineering, treating all the subjects usually included in that term. This edition has been extensively revised and many chapters have been rewritten. Much obsolete matter has been omitted and mercantile practice has been considered more fully than before.

Mechanical World Year Book, 1921. Manchester and London, Emmott & Co., Ltd. Cloth, 4 × 6 in., 318 pp., illus., 2s. 6d.

This inexpensive annual is intended as a convenient pocket

*(Continued on page 359)*

## AN INVESTIGATION OF OXY-ACETYLENE WELDING AND CUTTING BLOWPIPES

(Continued from page 310)

It was evident that further information was essential if a satisfactory analysis of welding-blowpipe performance was to be made. The greatest discrepancy from what was expected appeared to be in the high gas ratios obtained, and the first attempt to answer the problem was made by a study of gas-ratio phenomena. This seemed particularly desirable as it has been very firmly held by almost all authorities that good welding cannot be done with blowpipes having a high gas ratio.

An extensive series of supplementary gas-ratio tests was accordingly carried out. As a result of these tests a phenomenon of exceeding interest was developed, and gas ratios approaching very nearly the theoretical value obtained. The results obtained accounted partly for the quality of the welding work secured. In some respects, though, they added increased confusion by lack of consistency.

In further study of the data secured by the prescribed tests it was noticed that blowpipes that seemed especially susceptible to flashback were those in which the oxygen was delivered to the blowpipe at a pressure very much in excess of that at which the acetylene was delivered. It was further noticed, that even among such blowpipes, inconsistencies appeared. Critical examination of tip design in these blowpipes suggested a possible explanation. On this basis another series of supplementary tests was made, from the results of which data were secured that clearly explain the cause of flashback phenomena.

The logical continuance of the theory evolved for flashback leads directly to the question of safety in operation and correct gas ratio and will explain, in large part, the reason for so large a proportion of oxy-acetylene welds being of inferior grade.

The essential qualifications for a satisfactory welding blowpipe as enumerated above are therefore very intimately connected with the conditions governing flashback. It seems desirable, then, to begin the discussion of the results obtained in the tests of the investigation by the critical analysis of the conditions conducive to the development of flashbacks in welding blowpipes.

Any obstruction to the gaseous flow at the tip exit produces a back pressure that pushes back within the tip in the most direct line. An acetylene passage entering the oxygen tube at right angles has its flow cut off very quickly, especially when the oxygen pressure is much higher than the acetylene pressure and the point of admission of the oxygen is as it is in most of the tip designs beyond the point of admission of the acetylene. The checking of the acetylene flow is further assisted by the collapse of the partial vacuum and the infiltration of oxygen within the acetylene passage when the developed back pressure retards the aspirating effect existent in all tips of present design. Further, as Fig. 7 (p. 309) shows, in practically all designs the contracted throat is used in the acetylene passage, with the result that even in those blowpipes in which the acetylene is delivered at excess pressure or in which both gases are supposed to operate under equal pressures, a section of reduced or unbalanced pressure exists which is readily affected by the back pressure caused by obstructions at the tip end. It is perceived that under such conditions there are constant changes within the blowpipe tip in the desired one-to-one volume ratio of gases, with the result that a mixture leaner in acetylene is developed and flashback takes place.

The results of a series of gas-ratio tests, especially those run with diffraction gratings to examine the flame spectroscopically, are shown in Table 1 (p. 309), and it will be noticed that the use of gratings shows very marked changes in values. This table shows that practically any of the present blowpipes can be made to produce a neutral flame and burn equal volumes of oxygen and acetylene if the flame can burn undisturbed in the air. But, as indicated above, none of them can maintain such a flame during the welding process.

Referring to the strengths of the welds executed during these tests (see Table 2), it will be seen that the second plate welded during each test invariably showed the higher strength. It will be remembered that to counteract the effects of expansion the 2-ft. test welds were made by welding two 1-ft. lengths of plate. These plates were supported on a heavy iron casting that contained a channel throughout its length parallel to and directly under the line of welds. This channel caused the flame of the blowpipe to return under the plates being welded and thus preheated to some extent the second plate. Further, it caused a decided heating of the near end of the base casting. The explanation for the higher strength shown by the second plate probably lies in the more uniform preheating of the second plate and the greater annealing effect produced by the heated base casting, the latter causing a release of the tensile strains resulting from the contraction of the metal along the line of the weld.

The average strengths and average included angle of bend are given in the above-mentioned table (Table 2) for what they are worth. It is very probable in the light of present knowledge of the requirements of blowpipe design that some new ideas will be forthcoming concerning the average strength of oxy-acetylene welds. Finally in Fig. 8 are exhibited photomicrographs showing the effect upon the grain structure of the material, in this case mild steel, of the autogenous welding process, effects not necessarily detrimental when properly performed, but, as exhibited by the photomicrographs, instructive.

## BOOK NOTES

(Continued from page 358)

reference book for mechanical engineers and shop superintendents. The most-used data are given on steam engines and boilers, gas and oil engines, gas producers, the properties of metals, structural iron and steel work, toothed gearing, bearings, belting, friction and lubrication, steam fitting, screws and similar subjects. A buyer's directory is included.

A Treatise on Airscrews. By Whyrill E. Park. E. P. Dutton & Co., New York, 1921. (The Directly-Useful Technical Series). Cloth, 6 × 9 in., 308 pp., illus., diagrams, charts, tables, $8.

This book considers the problems of airscrew-propeller design and construction from the viewpoint of designers, draftsmen and others engaged in the practical design of aircraft. In general, it follows the methods developed by Lang Propeller, Ltd. It is intended to supply directly useful information, accompanied by a proper amount of scientific explanation. The theory presented is one that has proved convenient for drafting-room use.

A Treatise on Reinforced Concrete. By W. Noble Twelvetrees. Sir Isaac Pitman & Sons, Ltd., New York, 1920. Cloth, 6 × 8 in., 264 pp., plates, $7.50.

In this volume the author has endeavored to set forth as clearly as possible the general characteristics and distinctive properties of reinforced concrete and its constituents, to discuss in a systematic manner the principles underlying the design of homogeneous members, and to show how these principles may be applied to the evolution of formulas for the design of reinforced-concrete members of different classes. It is restricted to fundamental principles and presents a complete series of formulas for the principal classes of members employed in engineering and building construction. The book is the first to employ the standard notation adopted by the Concrete Institute. This notation is given in full, with an explanatory foreword.

Schmiede und Schmiede-Technik. By C. Oetling. Band 1. R. Oldenbourg, München und Berlin, 1920. Paper, 8 × 11 in., 621 pp., illus., diagrams, 90 Marks.

This volume is the outgrowth of a work submitted in 1911 to the Verein deutscher Maschinen-Ingenieure in competition for a prize offered for systematic study of the value of new methods and apparatus for forging. The report has been expanded, at the request of the prize committee, into an exhaustive examination of forge-shop methods. The present volume, the first of two, was printed in 1914, but has only now been published. It discusses fuels, heating furnaces, methods of controlling heat, forging hammers and presses, shears, saws, welding, measuring instruments, cranes and conveyors.

# THE ENGINEERING INDEX

*(Registered U. S. Patent Off.)*

*THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.*

*Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.*

**ACCIDENTS**

**Dust Explosions.** Some Electrical Causes of Dust Explosions, David J. Price. Jl. Electricity & Western Industry, vol. 46, no. 5, Mar. 1, 1921, pp. 240–242, 3 figs. Experiments and observations revealed that dust explosions may be produced by electrical bulbs broken in dust clouds, dust collecting on electrical lamps and static electricity produced by friction of finely divided materials.

**AERODYNAMICS**

**Laws.** Aerodynamics at Very High Speed, A. Guidoni. Aerial Age, vol. 13, no. 2, Mar. 21, 1921, pp. 31–32, 4 figs. Aerodynamic laws governing design of aeroplanes for extra fast service.

**AEROPLANE ENGINES**

**Compression Ratio and Thermal Efficiency.** Compression Ratio and Thermal Efficiency of Airplane Engines, S. W. Sparrow. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 266–268 and 281, 6 figs. Tests conducted by National Advisory Comm. for Aeronautics. Results showed that efficiency of combustion is influenced but little by change in density so long as temperature is maintained constant.

**Development.** Some Possible Lines of Development in Aircraft Engines, H. R. Ricardo. Aeronautical Jl., vol. 25, no. 123, Mar. 1921, pp. 130–145, 20 figs. Employment of kerosene mixtures as fuel, limiting size of cylinder, and possibilities of working with short compression and long expansion stroke are among chief possibilities considered.

**Efficiencies.** Aero Engine Efficiencies, A. H. Gibson. Aviation, vol. 10, no. 8, Feb. 21, 1921, pp. 238–240, 2 figs. Experimental examination of manner in which mechanical, volumetric and thermal efficiencies are effected by design and conditions of operation of engine. (Abstract.) Paper read before Royal Aeronautical Soc.

See also Thermal Efficiency.

**Fuel-Feed Systems.** Fuel Feed Systems for Airplanes, L. B. Lent. Aviation, vol. 10, no. 10, Mar. 7, 1921, pp. 294–298, 6 figs. Developments in planes operated by U. S. Air Mail Service. Critical study and suggestions in regard to improvements.

**Mounting.** The Installment of an Aeroplane Engine, A. J. Rowledge. Aeronautical Jl., vol. 25, no. 123, Mar. 1921, pp. 145–158 and (discussion) pp. 158–165, 9 figs. Typical mountings of aeroplane engines. Mounting with a view to simplifying attention of engine and making important parts accessible for repair and inspection.

**Napier Lion.** Some New Napier "Lion" Necessities and "The Cub." Flight, vol. 13, no. 6, Feb. 10, 1921, pp. 93–95, 6 figs. Accessory details on Napier "Lion" such as armouring of ignition cables with material that earths induced currents due to extreme high voltage, brass distributor shielding, and cut-out cock in return lead to pump from carburetor water-jacketing for flight in tropical climates.

**Packard.** An American Engine for Altitude Work, Jesse G. Vincent. Aviation, vol. 10, no. 9, Feb. 28, 1921, pp. 260–262, 5 figs. Packard type designed for work in high altitudes and recently completed for U. S. Army Air Service.

Special Packard Aero Engine for Altitude Work, Jesse G. Vincent. Aerial Age, vol. 12, no. 25, Feb. 28, 1921, pp. 631–633 and 643, 7 figs. Compression ratio is $6^1/_2$ to 1 and cylinder displacement 1237 cu. in. Throttle is provided as safety stop which is thrown off when altitude of 5000 ft. has been reached.

**Panhard-Levassor.** Panhard-Levassor 12-Cylinder Airplane Motor, F. P. Mann. Gas Engine, vol. 23, no. 3, Mar. 1921, pp. 75–76, 2 figs. Engine is V-type and develops 240 hp. at speed of 1350 r.p.m.

**Steadiness Factor.** The Steadiness Factor in Engine Sets, W. Margoulis. Aerial Age, vol. 12, no. 26, Mar. 7, 1921, pp. 659–661, 2 figs. Derivation of formula. Comparison of steadiness factor of engine sets and of engines having constant brake torque as function of speed rotation.

**Thermal Efficiency.** Means of Materially Increasing Thermal Efficiency, H. R. Ricardo. Automotive Industries, vol. 44, no. 8, Feb. 24, 1921, pp. 456–462, 10 figs. Use of stratified charges and other means for improving efficiency are outlined. Paper read before Royal Aeronautical Soc. of Great Britain.

See also Compression Ratio.

**AEROPLANE PROPELLERS**

**Parachutal Uses.** Study of the Resistance Furnished by an Aeroplane Propeller Rotating in a Current of Air (Étude sur la résistance fournie par les hélices tournant dans un courant d'air), M. Lamé. Aérophile, vol. 29, nos. 1–2, Jan. 1–15, 1921, pp. 5–7, 4 figs. Experiments were performed at Eiffel laboratory, Paris, to determine parachutal value of supporting propellers. Empirical formulas and laws are formulated from results obtained.

**Performance.** Experimental Research on Air Propellers—IV, W. F. Durand and E. P. Lesley. Nat. Advisory Committee for Aeronautics, no. 109, 1921, 11 pp., 12 figs. Investigations of performance of aeroplane propellers.

**AEROPLANES**

**Design.** Loads and Calculations of Army Aeroplanes, Ing. Stelmachowski. Aerial Age, vol. 13, no. 1, Mar. 14, 1921, pp. 9–11, 3 figs. Standards for calculation of aeroplane structures. Translated from Technische Berichte.

**Downwash.** The Determination of Downwash, Walter S. Diehl. Aerial Age, vol. 12, no. 26, Mar. 7, 1921, pp. 655–656, 6 figs. Derivation of downwash formula from Göttingen theoretical and Nat. Physical Laboratory empirical formulas. Technical note of Nat. Advisory Committee for Aeronautics.

**Helicopters.** See HELICOPTERS.

**Manufacture.** Details of Large Airplane Work. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 357–359, 8 figs. Fixtures used in wing construction. Increasing application of metal framing. Installing motors in planes. Methods of assembling fuselages.

**Speed Measurement.** Note on Measurement of Speed of Airplanes, S. Herbert Anderson. Aviation, vol. 10, no. 8, Feb. 21, 1921, pp. 233–234, 2 figs. Methods for finding true airspeed of airplane when there is wind, from data secured by timed flights over measured course.

**Stabilizers.** Visible Stabilization of Aeroplanes (Sichtbare Stabilisierung von Luftfahrzeugen), Friedrich Budig. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 2, Jan. 31, 1921, pp. 22–26, 5 figs. Auxiliary supporting plane, attachment indicating course of flight to aeroplane passengers as well as to pilot.

**Wings.** Some Experiments on Thick Wings with Flaps, C. D. Hanscom. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 271–276, 31 figs. Tests made in wind tunnel of Mass. Inst. of Technology with different models and designs of wings. The Handley-Page Aeroplane Wings, F. Handley Page. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 274–276, 21 figs. Paper read before Royal Aeronautical Soc.

The Handley Page Wing, F. Handley Page. Aeronautics, vol. 20, no. 384, 385 and 386, Feb. 24, Mar. 3 and 10, 1921, pp. 128–130, 16 figs., 153–154, 10 figs., and 167–168, 3 figs. Also Flight, vol. 13, no. 8, Feb. 24, 1921, pp. 130–137, 29 figs.; Aerial Age, vol. 13, no. 2, Mar. 21, 1921, pp. 37–38, 16 figs. Record of experimental work carried out with a view to overcoming phenomenon of "burbling." Experiments with slotted aerofoil. Paper read before Royal Aeronautical Soc.

[See also AIRCRAFT, Development during War.]

**AIRCRAFT**

**Developments During War.** The Evolution of Aeronautics During the War (L'evolution de l'aéronautique pendant la guerre), M. Renard. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 133, no. 1, Jan. 1921, pp. 21–51, 9 figs. Developments in design and construction of airships and aeroplanes.

**German Giant.** Development of Giant Aircraft in Germany. Aeronautical Jl., vol. 25, nos. 122–123, Feb. and Mar. 1921, pp. 100–116, 3 figs., and 166–188, 5 figs. Comparative study of types developed during the war. Economics of giant machine from military point of view. Visualization of best type from records of performance of giant German machines during war.

**Maintenance.** Ground Engineering, H. W. S. Outram. Aeronautics, vol. 20, no. 392, Feb. 10, 1921, pp. 96–98. British air navigation regulations for maintenance of aircraft at airdrome. Paper read before Royal Aeronautical Soc.

**AIRCRAFT CONSTRUCTION MATERIALS**

**Lugs.** Design of Standard Lugs, B. C. Boulton. Aerial Age, vol. 12, no. 25, Feb. 28, 1921, pp. 634–637, 8 figs. Summary of work done to determine correct design for standard lugs, notably by Material Section of McCook Field.

**Plywood.** See PLYWOOD.

**AIRSHIPS**

**Mooring and Handling.** A Stabilizing Raft for Mooring Airships Over the Sea, P. H. Sumner. Aeronautics, vol. 20, no. 382, Feb. 10, 1921, pp. 99, 4 figs. Raft fitted with stabilizing planes. Airship Mooring and Handling. Aeronautical Jl., vol. 25, no. 122, Feb. 1921, pp. 71–84 and (discussion) pp. 85–93, 13 figs. Survey of developments in Great Britain.

Note on the Mooring of Airships by "Free" Wire Systems, R. A. Frazer and L. F. G. Simmons. Aeronautical Jl., vol. 25, no. 122, Feb. 1921, pp. 94–99, 6 figs. Experiments conducted at Nat. Physical Laboratory, England.



Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

**Piloting.** Airship Piloting. Aeronautical Jl., vol. 25, no. 122, Feb. 1921, pp. 47–71, 5 figs. Controlibility under severe weather conditions. Technique of piloting. Methods of aerial navigation.

[See also AIRCRAFT, Development during War; HANGARS.]

**ALCOHOL**

**Industrial.** A New Alcohol from Oil—Not Potable. Compressed Air Mag., vol. 26, no. 3, Mar. 1921, pp. 10,005. "Petrohol" manufactured by the Standard Oil Co. of New Jersey from gases given off in cracking process of refining crude oil.

Alcohol Production from Molasses, George M. Appell. Chem. Age (N. Y.), vol. 92, no. 2, Feb. 1921, pp. 53–57, 1 fig. Diagram of classes of raw material and procedure of treatment for production of alcohol.

Industrial Alcohol Status in Canada. Can. Chem. & Metallurgy, vol. 5, no. 3, Mar. 1921, pp. 79–81. Legislation concerning manufacture of industrial alcohol.

Manufacture of Ethyl Alcohol from Wood Waste, E. C. Sherrard. Chem. Age (N. Y.), vol. 29, no. 2, Feb. 1921, pp. 76–79. Plant requirements.

**ALLOYS**

**Standardization.** Canadian Mechanical Standards. Paper, vol. 27, no. 26, Mar. 2, 1921, pp. 21–27 and 40, 12 figs. Report of Committee on Mechanical Standards of Canadian Paper & Pulp Assn. on standardization of metal alloys used in machinery employed for manufacture of paper. Investigations were conducted on acid-resisting bronze, properties of copper-tin-lead bronze, and antimonial lead, and also on a number of bearing metals.

**ALUMINUM**

**Castings.** Machining a Combined Bearing Housing and Control Bracket. Eng. Production, vol. 2, no. 20, Feb. 17, 1921, pp. 219–223, 13 figs. Quantity production of aluminum castings for automotive bearing housing and control bracket.

**Conductors.** The Use of Aluminum Conductors on Transmission Lines, Theodore Varney. Elec. News, vol. 30, no. 5, Mar. 1, 1921, pp. 30–34, 6 figs. Relative merits of steel-cored aluminum and copper conductors on level and rough courses discussed before Toronto Section, Am. Inst. Elec. Engrs.

**Ingots, Piping of.** Causes of Piping in Aluminum Ingots, Junius David Edwards and Harold T. Gammon. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 338–340, 12 figs. Measurements of piping and solidification shrinkage show that volume of pipe is dependent on four or even more definite factors, and that it is not specific property of metal or alloy.

**Nickel Plating of.** Nickel Plating of Aluminum (Le nickelage de l'aluminium), Léon Guillet. Mémoires et Compte rendu des Trauvaux de la Société des Ingénieurs civils de France, vol. 73, nos. 7, 8 and 9, July–Sept. 1920, pp. 453–470, 10 figs. Procedure.

**Sheet.** Stages in the Recrystallization of Aluminum Sheet on Heating; With a Note on the Birth of Crystals in Strained Metals and Alloys, H. C. H. Carpenter and Constance F. Elam. Advance Paper, no. 1, meeting of Inst. Metals, Mar. 9, 1921, 22 pp., 38 figs. Results of experiments.

The Recrystallization of Aluminium on Heating, H. C. H. Carpenter and Constance F. Elam. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 302–307, 38 figs. Stages in recrystallization of aluminum sheet on heating, with note on birth of crystals in strained metals and alloys. Interpretation of photomicrographs. Paper read before Inst. of Metals.

**Soldering.** A Great Progress in the History of Aluminum (Un grand progrès dans l'histoire de l'aluminium), Ch. Faroux. Vie automobile, vol. 17, no. 724, Feb. 25, 1921, pp. 66–67, 2 figs. Soldering aluminum by means of stagneol, an alloy which permits soldering of aluminum in the same manner and with same instruments as for tin soldering.

**ALUMINUM ALLOYS**

**Castings.** Analyze Loss in Aluminum Shops—VI, Robt. J. Anderson. Foundry, vol. 49, no. 5, Mar. 1, 1921, pp. 188–191. Reasons for Losses in production of aluminum alloys and castings.

Blowholes, Porosity, and Unsoundness in Aluminium Alloy Castings, Robert J. Anderson. Foundry Trade Jl., vol. 23, no. 237, Mar. 3, 1921, pp. 205–207, 8 figs. Data on six heats made on aluminum alloy, no. 12 (92 per cent aluminum and 8 per cent copper), to determine temperature effects.

**AMMONIA COMPRESSORS**

**Mean Effective Pressures.** Mean Effective Pressures John E. Starr. Refrigerating World, vol. 56, no. 3, Mar. 1921, pp. 11–12. Tables of multipliers of back pressure and temperature to obtain mean effective pressure and final gas temperatures in compressing gases.

**APPRENTICES, TRAINING OF**

**Systems.** Programs of Apprenticeship and Special Training in Representative Corporations—XI, J. V. L. Morris. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 505–507, 3 figs. Practice of Goodyear Tire & Rubber Co., Akron, Ohio. Instruction of many kinds is provided by industrial university.

**ARTILLERY**

**Matériel Developments.** The Development of Artillery Matériel, G. F. Jenks. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 167–172, 13 figs. Consideration of artillery-matériel development before war and effect of war upon it, both in U. S. and European countries. Efforts since war have been devoted chiefly to developments of pieces of greater range, greater elevation and greater mobility. Survey of developments of anti-aircraft matériel and coast-defense work is included.

**AUTOMOBILE ENGINES**

**Diesel Type.** Diesel Type of Engine for Motor Vehicle Work. Automotive Industries, vol. 44, no. 9, Mar. 3, 1921, pp. 501–509, 2 figs. Built by Deutsche Automobil Constructions Gesellschaft. Engine has two pistons in same cylinder and works on two-stroke cycle. Injection results from explosion in ignition chamber connected with combustion chamber by narrow passage.

**Manifold.** The L.O.A. Fuel Economiser. Autocar, vol. 46, no. 1321, Feb. 12, 1921, p. 295, 2 figs. Patented manifold where fuel charge is heated by exhaust gases.

**Manifolds, Intake Flow.** Intake Flow in Manifolds and Cylinders, P. S. Tice. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 282–284, 9 figs. Records of photographic measurements.

**Manufacture.** Special Machines and Tools in a Motor-Car Works. Machy. (London), vol. 17, no. 438, Feb. 17, 1921, pp. 609–612, 6 figs. Equipment used for milling crankcases, boring and reaming crankshaft and camshaft bearings and other operations.

**Packard Fuelizer.** The Packard Fuelizer, L. M. Woolson. Jl Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 240–248, 6 figs. Device used as substitute for hot-spot.

**Radiators.** The Manufacture of Radiator Gills, A. W. Allen. Machy. (London), vol. 17, no. 438, Feb. 17, 1921, pp. 606–607, 4 figs. Types of radiator gills. Tools used in their manufacture.

**Spring.** Rigid Construction and Clear Appearance Feature of New Engine, J. Edward Schipper. Automotive Industries, vol. 44, no. 9, Mar. 3, 1921, pp. 493–494, 3 figs. Four-cylinder engine designed by Frank S. Spring of Detroit. High power output and good fuel economy are claimed for engine.

**Valves.** The Graphical Analysis of Valve Gear. Automobile Engr., vol. 11, no. 147, Feb. 1921, pp. 66–67, 4 figs. Simplified method of investigation.

**AUTOMOBILE FUELS**

**Alcohol.** Possibilities of Alcohol for Fuel, A. H. Gilbert. Agricultural Eng., vol. 2, no. 1, Jan. 1921, pp. 5–6. Summary of research conducted by technical institutions and government agencies. Committee report presented at meeting of Am. Soc. of Agricultural Engrs.

[See also ALCOHOL, Industrial.]

**Characteristics.** The Character of Various Fuels for Internal Combustion Engines,—I. H. T. Tizard and D. R. Pye. Automobile Engr., vol. 11, no. 147, Feb. 1921, pp. 55–57. Theoretical investigation of influence of specific heat and dissociation of working fluid, made preliminary to experimental investigation conducted by H. R. Ricardo.

**Tests.** The Character of Various Fuels for Internal Combustion Engines,—II H. T. Tizard and D. R. Pye. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 98–101, 2 figs. Influence of specific heat and dissociation of working fluid. Calculation of maximum temperature allowing for dissociation.

The Influence of Various Fuels on the Performance of Internal Combustion Engines—II, H. R. Ricardo. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 92–97, 7 figs. Experimental investigation into behavior of various automobile fuels. Graphs are given which show relation between air cycle standard efficiency and compression ratio, also variation in mean effective pressure and thermal efficiency with different compression ratios for fuel detonating normally at compression of 5 to 1.

**Vegetable Oils.** Vegetable Oils as Fuel for Internal Combustion Engines. Engr., vol. 121, no. 3402, Mar. 11, 1921, pp. 255–256. Experiments on utilization of palm oil as engine fuel. Reports submitted to Assn. for the Improvement of Belgian Colonies.

[See also ALCOHOL; BENZOL; GASOLINE.]

**AUTOMOBILES**

**Axles.** Stub-Axle Stresses, J. L. Napier. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 82–83, 2 figs. Study on stresses and their relation to side-slip.

**Design.** Need for Greater Service Accessibility in Car Design, T. F. Cullen. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 257–264, 13 figs. Survey of automobiles in regard to accessibility of parts for repairs. Suggestions for increasing accessibility.

Why American, British and Continental Car Designs Differ, M. Olley. Automotive Industries, vol. 44, no. 10, Mar. 10, 1921, pp. 547–553. Writer discusses effect of customs, climate, road conditions, taxes, operating costs, size of industry, point of view and competition upon size, cost, appearance and design of passenger cars. Motoring here is characterized as transportation, while in Europe spirit of adventure still dominates. Considers American braking systems defective.

**Landing Gear.** The Klemin Amphibious Gear, Donald W. McIlhiney. Aviation, vol. 10, no. 9, Feb. 28, 1921, pp. 271–272, 2 figs. Landing gear composed of ordinary wheel structure and tail skid, both of these parts being retractable.

**Manufacture.** A Modern Chassis Assembly Plant. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 102–104, 6 figs. Methods of Standard Motor Co., England.

Methods in a Continental Works. Eng. Production, vol 11, no. 19, Feb. 10, 1921, pp. 195–203, 32 figs. Belgian factory manufacturing motor cars, motorcycles, small arms, small-caliber ammunition and pedal cycles.

**Radiators, Alcohol-Water Mixtures for.** Report Giving Tables Showing the Freezing Points and Specific Gravity of Alcohol-Water Mixtures. Air Service Information Circular, vol. 12, no. 178, Jan. 20, 1921, 6 pp., 2 figs.

**Transmissions.** Developments in Transmission, S. Bramley-Moore. Automobile Engr., vol. 11, no. 147, Feb. 1921, pp. 70–75, 33 figs. Developments in clutch and gear-box design.

Gear Box vs. Electrical Transmission. Autocar, vol. 46, no. 1319, Jan. 29, 1921, pp. 189–192, 11 figs. Relative merits of various transmission systems. It is claimed that electric transmission affords greater comfort and longer tire life. Curves are given showing comparative efficiencies of electrical and other methods of power transmission.

**Wheel Hubs, Standardization.** Move to Unify All Interest in Hub Standardization Work, J. Edward Schipper. Automotive Industries, vol. 44, no. 11, Mar. 17, 1921, pp. 592–594, 1 fig. Standardization for ball-bearing front-axle hubs proposed by representatives of ball-bearing manufacturers at joint meeting with Soc. Automotive Engrs.

**AVIATION**

**Aerial Transportation.** Aeroplane & Seaplane Transport Efficiency, H. White-Smith. Aeronautics, vol. 20, no. 385, Mar. 3, 1921, pp. 151–152. Mobility, safety, reliability and economy of working of aerial transportation. (To be continued.) Paper read at Olympia Efficiency Exhibition.

The Cost of Aerial Transportation (Die Kosten der Luftreise), Alexander Baumann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 2 and 3, Jan. 31 and Feb. 15, 1921, pp. 17–20 and 33–35. Points out that if air traffic is to become firmly established, the costs must be reduced. This is possible in a slight degree through constructive methods referred to, but in a far greater degree through establishment of effective traffic routes, proper emergency landings, etc.

**Civil.** America's First Model Airway. Aviation, vol. 10, no. 9, Feb. 28, 1921, pp. 267–270, 1 fig. Proposed model airway from Washington, D. C., to Dayton, Ohio.

Status of Commercial Aircraft Shown by Company Development. Automotive Industries, vol. 44, no. 10, Mar. 10, 1921, pp. 559–561. List of flying companies operating in U. S. There are 88 companies operating about 400 aircraft units.

The Operation of Civil Aircraft in Relation to the Constructor, H. White-Smith. Flying, vol. 10, no. 2, Mar. 1921, pp. 47–59. Costs of operating commercial air services. Present position of seaplanes, flying boats and amphibians.

U. S. Commercial Aircraft Companies. Aviation, vol. 10, no. 10, Mar. 7, 1921, pp. 299–301. List of commercial aircraft operating companies in the United States and Canada, with account of air port facilities and aircraft owned and rates of service.

**Commercial.** Norway's Experience of Commercial Aviation. Flight, vol. 13, no. 6, Feb. 10, 1921, pp. 96–97, 3 figs. Records of air service in Norway.

Winged Transportation, Ladislas d'Orcy. Sci. Am., vol. 124, no. 9, Feb. 26, 1921, pp. 168–169, 3 figs. Survey of commercial air service in U. S., Europe and South America. List of world's air transport services.

**Soaring Flight.** Soaring Flight, M. A. S. Riach. Aeronautics, vol. 20, nos. 383–384, Feb. 17 and 21, 1921, pp. 117–118, 7 figs., and 132–134, 1 fig. Study of forces acting.

# B

**BEARING METALS**

See ALLOYS, Standardization.

**BEARINGS, BALL**

**Housings.** Manufacturing a Ball Bearing Housing. Eng. Production, vol. 11, no. 19, Feb. 10, 1921, pp. 180–184, 10 figs. Jigs and tools for manufacturing small ball-bearing housings in quantities.

**BENZOL**

**Specifications.** New Purity Standard for Benzole. Autocar, vol. 45, no. 1323, Feb. 26, 1921, pp. 369. Specifications adopted by British Eng. Standards Assn.

**BLAST-FURNACE GAS**

**Cleaning Process.** Recovery Process for Flue Dust, George B. Cramp. Blast Furnace & Steel Plant, vol 9, no. 3, Mar. 1921, pp. 198–202, 1 fig. Claims that first cost of direct-recovery plant is smaller than that of any other process, and also that operating expenses are very low.

**Gas Balances.** The Relative Distribution of Blast-Furnace Gases as Fundamental Basis of the Heat Economics of Mixed Steam and Gas Power Installations (Die bilanzmässige Verteilung der Gichtgase als Grundlage der Wärmewirtschaft gemischter Werke), G. Schulz. Stahl u. Eisen, vol. 41, no. 5, Feb. 3, 1921, pp. 145–149 and (discussion) pp. 149–150, 5 figs. Results of work of a special commission of engineers in drawing up a gas balance for blast-furnace gases.

**Measurement.** Measurement of Blast-Furnace Gas, D. L. Ward. Min. & Metallurgy, no. 170, Feb. 1921, pp. 33–34, 1 fig. Study to determine how much surplus power could be produced through proper utilization of entire gas flow from two furnace

stacks at Federal Furnace Plant, South Chicago, Ill., Method of measuring flow of gas.

### BLAST FURNACES

**Air Preheaters.** Air Preheaters (Kritische Bemerkungen über Winderhitzer), Emil Wurmbach. Stahl u. Eisen, vol. 41, no. 3, Jan. 20, 1921, pp. 74–76, 1 fig. Critical discussion of heat transmission from the heating gas to the bricks and from these to the blast.

**600-Ton** New Blast Furnace Recently Completed. Iron Age, vol. 107, no. 9, Mar. 3, 1921, pp. 570–575, 7 figs. 600-ton furnace furnished with 92-ft. stack, 18-ft. hearth, 22-ft. 6-in. bosh and 16-ft. diameter stock line.

### BOILER FEEDWATER

**Treatment.** Control of Salt Content in Boiler Water, Claude C. Brown. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 264–266, 4 figs. Chart showing amount of blowdown necessary for varying degrees of salinity and varying boiler ratings.

Degassing and Purification of Boiler Feed Water, Paul Kestner. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 291. Process of continuous blowing down used in conjunction with hot purification. (Abstract.) Paper read before joint meeting of Instn. Mech. Engrs. and Soc. Chem. Industry.

Kestner Apparatus for Removal of Gases from Feedwater (L'appareil dégazeur Kestner), M. Perdrizet. Revue générale de l'Electricité, vol. 9, no. 6, Feb. 5, 1921, pp. 185–187, 4 figs. Mechanical and chemical degasification.

"Pure" Water for Locomotives, Paul M. LaBach. Ry. Rev., vol. 68, no. 12, Mar. 19, 1932, pp. 456–460. Suggestions in regard to making calculations involved in computing amount of ingredients to use in treatment processes.

### BOILER INSPECTION

**Legislation.** Uniform Boiler Inspection Laws, C. O. Meyers. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 288–289. Advantages sought and difficulties encountered in enforcement. Experience in Ohio.

### BOILER OPERATION

**Gas-Fired Boilers.** Investigation of Gas-Fired Steam Plant, R. L. Ellis. Power, vol. 53, no. 12, Mar. 22, 1921, pp. 472–473, 1 fig. Study in operating efficiencies and control methods in 48,000 sq. ft. boiler plant using coke oven gas as fuel. Results show $CO_2$ flue-gas content reliable efficiency indicator, and excess air not requisite for practically complete combustion.

**Instruments.** A Continuous Densimeter for Boilers. Engr., vol. 131, no. 3398, Feb. 11, 1921, pp. 157–158. Patented apparatus for ascertaining density of boiler water. Principle of operation is that column of distilled water is balanced against column of water contained in boiler.

### BOILERS

**Baffling.** Recent Practice in Baffling Boilers, Kingsley L. Martin. Power Plant Eng., vol. 25, no. 6, Mar. 15, 1921, pp. 135–137, 4 figs. Typical installations of baffles.

**Capacity Limitations.** Ultimate Boiler Capacity Limited by Stoker Conditions, Joseph Harrington. Elec. Rev. (Chicago), vol. 78, no. 12, Mar. 19, 1921, pp. 451–453, 2 figs. Size and distribution of air openings through grates. Forced draft required to overcome resistance in fuel bed. Formation of clinker influenced by character of coal and other factors.

**Feed Regulator.** "Anthony" Patent Feed Regulator. Steamship, vol. 32, no. 380, Feb. 1921, pp. 196–198, 2 figs. Patented regulator in which no additional valve for regulating feed water admission need be used, as the special valve provided with apparatus is in itself an automatic check valve, and can be fitted with an isolating valve.

### BOILERS, WATER-TUBE

**Marine.** Water-Tube Marine Boiler (Chaudière marine à tubes d'eau). Bulletin technique du Bureau Veritas, vol. 3, no. 2, Feb. 1921, pp. 55–56, 2 figs. Patented boiler with lateral superheater composed of tubes running in longitudinal direction of boiler. Built by Schmidt'sche Heissdampf Gesellschaft.

### BRASS

**Cobalt.** Cobalt Brasses, Leon Guillet. Chem. & Metallurgical Eng., vol. 24, no. 10, Mar. 9, 1921, pp. 439–443, 11 figs. Experimental comparison of role of cobalt with that of nickel in manufacture of copper-zinc alloys.

**Season Cracking.** The Season-Cracking of Brass and Other Copper Alloys, H. Moore, S. Beckinsale and Clarice E. Mallinson. Advance Paper, no. 5, meeting of Inst. Metals, Mar. 10, 1921, 91 pp., 23 figs. Experimental investigation of causes of season-cracking at Research Dept., Woolwich, England.

### BROACHING MACHINES

**Vickers.** A New Broaching Machine. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, p. 3289, 2 figs. Machines manufactured by Vickers Works, London, England.

### BUILDING CONSTRUCTION

**Metal Lath Application.** The Correct Application of Metal Lath to Avoid Plaster Cracks. Am. Architect, vol. 119, no. 2358, Mar. 2, 1921, pp. 246–250, 12 figs. Results of tests recently conducted at Armour Institute, showing best forms of application.

## C

### CABLES, HOISTING

**Metallic, Resonance in.** Resonance in Metallic Hoisting Cables (La résonance dans les cables d'extraction métalliques), R.-A. Henry. Revue universelle des Mines, vol. 8, no. 3, Feb. 1, 1921, pp. 173–186, 4 figs. Graph is constructed for determining loading and speed which will prevent resonance vibrations in cables of various dimensions.

### CAMS

**Design.** Harmonic Cams With Flat Followers, R. J. Cousins. Automobile Engr., vol. 11, no. 147, Feb. 1921, p. 42, 3 figs. Principles involved in design of cam acting directly on flat-ended tappet.

### CAR CONSTRUCTION

**Support on Truck.** New Type of Support for Railway Cars (Nouveau type de suspension pour voiture à bogies). Génie Civil, vol. 78, no. 8, Feb. 19, 1921, pp. 178–179, 1 fig. Pendulum support. From Revue générale des Chemins de fer.

### CAR COUPLERS

**Failure.** Causes of the Rupture of Railway Car Couplings (Les causes des ruptures d'attelages de chemins de fer). Génie Civil, vol. 78, no. 10, Mar. 5, 1921, pp. 212–215, 14 figs. Interpretation of photomicrographs of ruptured specimens. Failure is attributed to carelessness in forging and insufficiency of elastic resistance in traction springs.

### CAR WHEELS

**Chilled Cast-Iron.** Instruction for Grinding Chilled Cast Iron Car Wheels. Ry. Mech. Engr., vol. 95, no. 3, Mar. 1921, pp. 181–183. Practice of Atchison, Topeka and Santa Fe Railroad. Tables giving grinding diameters for slid flat wheels.

### CARS

**Automatic Connector.** The Futrell Automatic Train Line Connector. Ry. Age., vol. 70, no. 9, Mar. 4, 1921, pp. 516–518, 6 figs. Features are arrangements for locking heads and taking care of movement between couple cars.

**Container.** Container Car in Express Service on N. Y. C. Lines. Ry. Mech. Engr., vol. 95, no. 3, Mar. 1921, pp. 171–172, 4 figs. Experimental container car operated by Am. Ry. Express between New York and Chicago. Car consists of nine separate containers or steel boxes firmly secured on car to prevent shifting during train movement. Each container is removable so that it may be transported by motor truck between stores or factories and railroad.

**Diesel-Electric.** The Diesel Engine in Railroad Service. Ry. Mech. Engr., vol. 95, no. 3, Mar. 1921, pp. 156–159. Diesel-electric cars on Swedish railways.

### CARS, FREIGHT

**Cost of Reproduction.** The Cost of Reproduction of New Steel Freight Cars. Ry. Age., vol. 70, no. 10, Mar. 11, 1921, pp. 553–556, 4 figs. Report issued by Equipment Committee of Presidents' Conference Committee on Federal Valuation. Gondola, hopper, coke and tank cars are taken up. Price is based on weight of so called base car to which price are added certain net figures to cover cost of specialties.

**Six-Wheel Truck.** The Lamont Six-Wheel Truck for Freight Cars. Ry. Age, vol. 70, no. 11, Mar. 18, 1921, pp. 729–731, 4 figs. Side frames are continuous over three journals. Special design of equalizing system used.

### CASE-HARDENING

**Cyanide Action.** True Action of Cyanide in Case Hardening Steel, G. R. Brophy and S. B. Leiter. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 330–338, 13 figs. Interpretation of photomicrographs.

**Cyanogen Case Carburizing.** A New Method of Case-Hardening Steel, W. J. Merten. Can. Machy., vol. 25, no. 9, Mar. 3, 1921, pp. 77–80, 1 fig. Steel and iron alloy articles are case-hardened in stream of cyanogen gas evolved from container filled with an alkali cyanide salt, heated by electrical energy or other means to accomplish vaporization of salt.

**Ingots During Casting.** The Composite Process of Carburisation of Steel During Casting, Major Waddington. Iron & Coal Trades Rev., vol. 102, no. 2766, Mar. 4, 1921, p. 311, 3 figs. Ingot mold was lined on one side only with amorphous carbon blocks. Rail was subsequently rolled from ingot, running surface of rail corresponding to side with greater carbon content.

**Tests.** A Research in Case Carbonizing, G. S. McFarland. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 297–305, 24 figs. Comparison of 5 per cent nickel steel, carbon steel and chrome-vanadium steel when used for case carbonizing. Nickel steel proved superior to other two.

### CAST IRON

**Tests.** Mechanical Tests for Cast Iron—Part I, F. G. Cook. Foundry Trade Jl., vol. 23, no. 234, Feb. 10, 1921, pp. 132–134. Survey of tests usually required by engineers' specifications and of those adopted as guide to efficient working in foundry. (To be continued.) Paper read before London Branch, Instn. British Foundrymen.

### CEMENT

**Slag.** Slag Cement (Béton de scories), B. Jeanneret. Bulletin technique de la suisse romande, vol. 47, no. 3, Feb. 5, 1921, pp. 27–29, 2 figs. Tests of strength of blast-furnace slag cement.

### CENTRAL STATIONS

**Economical Advantages.** Progress of the Superpower Survey. Elec. World, vol. 77, no. 10, Mar. 5, 1921, pp. 539–540. Annual saving to railroads of $90,000,000 through electrification and of 4,000,000 tons of coal by the utilities, together with legislative and financial program, stated in superpower survey being made under auspices of United States Dept. of the Interior.

Progress Report of Superpower Survey. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 395–396. Preliminary report covering investigations of superpower survey being made under auspices of United States Dept. of Interior.

Progress Report on the Superpower Survey. Ry. Age, vol. 70, no. 11, Mar. 18, 1921, pp. 727–728. Cost of electrifying railroads within Boston-Washington industrial region estimated at $40,000 per mile. Progress report on work of superpower survey submitted to president by Secretary of Interior.

Superpower and Its Relation to Industry, Henry Flood, Jr. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 3, Mar. 1921, pp. 192–197, 3 figs. Intense industrial development results from central station practice in large demand for power to operate industries and to provide transportation both for raw material into region and for finished products to people outside of it.

Super-Power Stations for Central Indiana, Frederick L. Ray. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 262–264, 1 fig. General outline of needs, advantages and possibilities of system of generating stations, located in coal mining districts, supplying power to entire central part of state.

**Steam Hydraulic Relay Service.** Steam Stations for Hydraulic Relay Service, E. B. Powell. Power Plant Eng., vol. 25, no. 6, Mar. 15, 1921, pp. 310–315, 6 figs. Consideration of design factors of various types of supplementary power schemes available. Paper presented at joint meeting of Boston Sections of Am. Soc. Mech. Engrs., Am. Inst. Elec. Engrs., and Boston Soc. Civil Engrs.

**Superpower.** Industries and Superpower, Harold Goodwin, Jr. Jl. Engrs. Club of Phila., vol. 38, no. 194, Feb. 1921, pp. 63–68, 5 figs. Survey of power consumption in northeastern part of U. S., including greater part of New England and New York, New Jersey and Delaware, and part of Pennsylvania and Virginia. Figures of 1914 census indicate that there are about 10,000,000 hp. in zone, and that coal consumption amounts to 60,000,000 tons per annum. Advantages of centralizing power generation are pointed out.

### CLOTHS

**Mechanical Uses.** Cloths for Mechanical Uses, James W. Cox, Jr. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 177–180 and 220. Classification of cloths, enumeration of industries in which they are used, and exposition of their specific uses as absorptives, and for belting, conveying, filtering, etc.

### COAL

**Briquetting.** Briquetted Coal for Household Fuel, J. H. Kennedy. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 101–106. European practice.

**Cannel.** Cannel Coal in Southern Utah, C. A. Allen. Reports of Investigations, Bureau of Mines, Dept. of Interior, Feb. 1921, serial no. 2221, 3 pp. Possibilities of commercial utilization. Over 68 gal. of oil were recovered per ton of coal in experiments.

**Recovery from Furnace Refuse.** Recovery of Coal from Furnace Refuse. (Kohlengewinnung aus den Feuerungsrückständen). Zeit. für die gesamte Giessereipraxis, vol. 42, no. 3, Jan. 15, 1921, pp. 36–38, 1 fig. "Kolumbus" coke separator based on principle of separation of coke and slag through specific weight.

### COAL DEPOSITS

**Pennsylvania.** Pennsylvania Coals and Shales Greatly Vary in Their Content of Oil, Geo. H. Ashley and Chas. R. Fettke. Coal Age, vol. 19, no. 9, Mar. 3, 1921, pp. 401–403. Comparison of coal deposits and oil resources of Pennsylvania with those of other states.

### COAL DUST

**Precautions against.** Precautions Against Coal Dust. Iron & Coal Trades Rev., vol. 102, no. 2765, Feb. 25, 1921, p. 283. Orders issued by British Secretary of Mines regarding tests to be adopted in connection with precautions against coal dust.

### COAL HANDLING

**Brown Electric Shovel.** By Making Boom Horizontal, Surface Type of Shovel is Adapted to Mine Work, D. C. Ashmead. Coal Age, vol. 19, no. 9, Mar. 3, 1921, pp. 395–396, 2 figs. Brown electric shovel provided with horizontal boom, automatic dipper trip and conveyor.

### COAL WASHING

**Froth Flotation.** Purification of Coal by Froth Flotation. Colliery Guardian, vol. 121, no. 3136, Feb. 4, 1921, pp. 337. Process for recuperating coal dust from refractory fines.

### COKE OVENS

**Linings.** Silica Bricks for Coke Ovens. Iron & Coal Trades Rev., vol. 111, no. 2764, Feb. 18, 1921, pp. 232–233. Comparison of silica and firebrick linings.

### COMBUSTION

**Control.** Control of Combustion (La comburimétrie industrielle), A. Grebel. Génie Civil, vol.

78, nos. 4 and 5, Jan. 22 and 29, 1921, pp. 78-82, 4 figs., and 103-104, 3 figs., Jan. 22. Grebel-Velter apparatus for controlling combustion. Jan. 29: The Frère air recorder.

**Stephens Process.** Grateless, Smokeless, Automatic Furnace for Steam Power Production at the Mines. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, p. 229, 1 fig. Downward sweep of air coming through front of furnace carries measured quantities of fuel consisting of dust and fine particles up to pieces 3/4 in. in size. Dust and fine particles burn in suspension. While burning particles are agitated in vortex maintained within furnace chamber.

### CONCRETE

**Proportioning Aggregates.** New Methods of Proportioning Concrete. Can. Engr., vol. 40, no. 9, Mar. 3, 1921, pp. 263-265. Specifications adopted by Hydroelectric Power Commission of Ontario.

**Use in Sea Water.** Report of Committee VIII—On Masonry. Bul. Am. Ry. Eng. Assn., vol. 22, no. 233, Jan. 1921, pp. 543-564, 11 figs. Disintegration of concrete and corrosion of reinforcing materials in connection with use of concrete in sea water. Effect upon strength and durability of concrete not having sufficiency of moisture present throughout period of hardening.

**Waterproof.** How Concrete is Made Waterproof. James Scott. Contract Rec., vol. 35, no. 8, Feb. 23, 1921, pp. 198-199, 4 figs. Analysis of microscopical actions and chemical modifications taking place on addition of "pudlo" to concrete.

**Wear Under Water.** Water Content Affects Wear of Concrete Test Pieces. Dan Patch. Eng. News-Rec., vol. 86, no. 9, Mar. 3, 1921, pp. 373, 1 fig. Report of behavior of test pieces placed in Boston harbor in 1909.

### CONCRETE CONSTRUCTION, REINFORCED

**Calculation.** Short Cuts for Calculating and Estimating Reinforced Concrete. Milo S. Farwell. Am. Architect, vol. 119, no. 2358, Mar. 2, 1921, pp. 251-254, 14 figs. Graphs for computing costs.

### CONDENSERS, STEAM

**Cooling of Water in Canal.** The Cooling of Water in a Canal. L. C. Kemp. English Elec. Jl., vol. 1, no. 5, Jan. 1921, pp. 210-222, 8 figs. Experiments carried out at Lero Road Power Station, Leicester, England. Situated on banks of canal upon which it relies entirely for cooling of circulating water for condensers.

**Incrustation.** The Scam-Balcke Process for Preventing Incrustation in Surface Condensers (La "vaccination" des eaux de circulation des condenseurs à surface par le procédé Scam-Balcke). Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 153-157, 12 figs. Addition of hydrochloric acid to transform carbonates into chlorides is basis of process.

**Tests.** Test Results of a 50,000 Square-Foot Surface Condenser. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 414-416, 4 figs.

### COPPER ALLOYS

**Copper-Tin.** The Constitution of the Alloys of Copper with Tin. Parts III and IV. John L. Haughton. Advance Paper no. 6, meeting of Inst. Metals, Mar. 10, 1921, 22 pp., 23 figs. Experimental study of transformations other than formation of eutectic occurring below 250 deg. cent.

**Plastic Deformation.** Plastic Deformation of Some Copper Alloys at Elevated Temperatures. C. A. Edwards and A. M. Herbert. Advance Paper, no. 3, meeting of Inst. Metals, Mar. 9, 1921, 25 pp., 11 figs. Experimental investigation.

### CORROSION

**Browning Rust-Prevention Process.** Rust Prevention by Browning Process. W. C. Marshall. Automotive Industries, vol. 44, no. 10, Mar. 10, 1921, pp. 556-558. Specifications for preparation of solutions and methods of application.

**Steel Containing Copper.** Corrosion Tests with Steel Plates Containing Copper (Rostversuche mit kupferhaltigen Eisenblechen). O. Bauer. Stahl u. Eisen, vol. 41, nos. 2 and 3, Jan. 13 and 20, 1921, pp. 37-45 and 76-83, 11 figs. Account of tests carried out in a pure atmosphere (on roof of material-testing station in Berlin-Dahlem), at the seashore (North Sea), and in industrial district in Westphalia. It is shown that a small addition of copper to iron is a good protection against unfavorable effect of sulphuric acid; phosphorus greatly increases the susceptibility of iron to sulphuric acid and addition of copper neutralizes to certain extent the unfavorable action of phosphorus.

### COST ACCOUNTING

**Indirect Costs.** Aligning the Power Plant with the Cost Department. Malcolm C. W. Tomlinson. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 171-172. Suggestions in regard to reducing power, light and heat costs.

**Relation to Production.** Costing Methods and Increased Productivity. H. W. Allingham. Eng. & Indus. Management, vol. 5, no. 7, Feb. 17, 1921, pp. 196-198. Discussion held under auspices of British Instn. of Cost and Works Accountants.

### CRANE HOOKS

**Stresses in.** The Strength of a Hook or "Clivvy." Charles D. Mottram. Colliery Guardian, vol. 121, no. 3137, Feb. 11, 1921, pp. 411-412, 4 figs. Measurement of stresses in crane hook where maximum load was 5 tons.

### CRANES

**Shipyards.** Shipyard Cranes. H. H. Vernon. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 230-233, 11 figs. Typical installations of electrically-operates cranes at American shipyards.

### CRANKSHAFTS

**Manufacture.** Crankshaft Turning Practice. J. V. Hunter. Am. Mach., vol. 54, no. 11, Mar. 17, 1921, pp. 456-458, 7 figs. Cheeks, pins and bearings turned in special lathes. Shafts driven from both ends by pot-chucks. Special tooling methods employed.

Quantity Making of Crankshafts. Abrasive Industry, vol. 2, no. 2, Feb. 1921, pp. 49-52, 6 figs. Methods at plant of Automobile Crank Shaft Corp., Detroit.

### CYLINDERS

**Boring.** Methods in a Tractor Engine Plant. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 641-644, 8 figs. Method of machining cylinder liners on rotary type of boring machine at plant of Avery Co., Milwaukee.

# D

### DIES

**Curling.** Curling Die Construction. J. Bingham. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 651-652, 4 figs. Punch and die designed to flange out bottom of drinking cup shell and to curl top.

**Drop-Forging.** Life of Drop Forge Dies. J. S. Glover. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 120-123, 1 fig. Suggests general systematic handling scheme.

**Electrical Fixtures.** Dies for Electrical Terminals and Connectors. John A. Honegger. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 626-629, 10 figs. Dies employed in manufacture of connectors or terminals for wires of electric lighting units.

**Manufacture.** Dies for Hemispherical, Conical and Other Flanged Shells. J. Bingham. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 546-548, 8 figs. Details of manufacture and methods of operation.

**Piercing.** The Design and Construction of Press Tools—II. Eng. Production, vol. 2, no. 20, Feb. 17, 1921, pp. 212-214, 7 figs. Types of piercing dies.

### DIESEL ENGINES

**Burmeister-Wain.** First Details of New Burmeister and Wain Engine for Single Screw Motorships. Motorship, vol. 6, no. 3, March 1921, p. 216, 2 figs. Long-stroke Diesel engines with piston removable from below.

**Canadian-Built.** The First True Diesel Made in Canada. Power House, vol. 14, no. 5, Mar. 5, 1921, pp. 21-24, 8 figs. Also Can. Machy., vol. 25, no. 11, Mar. 17, 1921, pp. 41-44, 8 figs. Description of 100 b.hp. four-cylinder Diesel engine built by Dominion Steel Products Co.

**Double-Acting.** The Double-Acting Diesel Engine. A.P. Chalkley. Pacific Mar. Rev., vol. 18, no. 3, Mar. 1921, pp. 149-150, 4 figs. Installation in motorship "Assyrian."

**Installations in United States.** The Diesel-Engine Industry. L. H. Morrison. Power, vol. 53, no. 9, Mar. 1, 1921, pp. 336-340, 6 figs. Table giving Diesel-engine installations in U. S. by industries, also statistics on installations by states.

**Marine.** Cooling of Cylinders and Pistons of Marine Diesel Engines. Louis R. Ford. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 426-429, 3 figs. Study of causes of typical piston failures.

Diesel Engine Crankshafts. Joseph Hecking. Mar. Eng., vol. 26, no. 2, Feb. 1921, pp. 147-153, 9 figs. Investigation made in connection with classification rules of Am. Bur. of Shipping.

**Standardization.** Standardized Diesel Engines. H. R. Setz. Mar. Eng., vol. 26, no. 3, Mar. 1921, pp. 222-228, 6 figs. Suggestions in regard to standardization of four-cycle type. (To be continued.)

### DRAWING

**Machine Parts.** The Relative Economic Value of Drawn Machine Parts and Those Machined from Solid Materials (Wirtschaftlicher Vergleich zwischen gezogenen und aus Vollmaterial hergestellten Maschinenteilen). K. Brendle. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 207-210, 8 figs. A typical example, with preliminary calculations and comparative tables, are given to show that parts machined from solid material could often be produced at much lower cost through drawing.

### DRILL CHUCKS

**Interchangeable Manufacture.** Application of Interchangeability to Drill Chuck Manufacture. Fred. R. Daniels. Machy. (N. Y.), vol. 27, nos. 6 and 7, Feb. and Mar. 1921, pp. 509-515, 9 figs., and 674-679, 18 figs. Tooling and gaging equipment used by Marvin & Casler Co., Canastota, N. Y., in manufacturing Casler twin-screw drill chuck.

### DRILLING MACHINES

**Multiple.** A Machine for Multiple Drilling and Tapping. Automotive Industries, vol. 44, no. 11, Mar. 17, 1921, pp. 611. Employs automobile type friction clutch in main driving pulley to enable power to be shut off when change in direction of rotation of spindles is made.

### DRILLS

**Pneumatic.** Four-Cylinder Pneumatic Drill. Engineering, vol. 111, no. 2879, Mar. 4, 1921, p. 253, 4 figs. Light design with aluminum castings.

### DUST

**Determination in Air.** Efficiency of the Sugar-Tube Method for Determining Dust in Air. A. C. Fieldner, S. H. Katz and E. S. Longfellow. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 119-123, 2 figs. Experiments at U. S. Bur. of Mines.

**Removal from Grinding Plants.** Investigation of Dust in the Air of Granite-Working Plants. S. H. Katz. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2213, 2 pp. Methods used by U. S. Bureau of Mines in cooperation with Granite Manufacturers' Assn. for determining dustiness in granite-working plants.

Reducing Grinding Hazards. Abrasive Industry, vol. 2, no. 2, Feb. 1921, pp. 37-41, 9 figs. Tests conducted in various manufacturing plants by the U. S. Public Health Service revealed that grinders' consumption is prevalent to a great extent in wet grinding plants. Methods of disposing of dust are surveyed.

### DYNAMOMETERS

**Froude Hydraulic.** The Froude Hydraulic Dynamometer. C. H. Peabody. Mar. Eng., vol. 26, no. 3, Mar. 1921, pp. 244-247, 4 figs. Reversible and non-reversible types built in standard sizes up to 6000 hp. by C. H. Wheeler Manufacturing Co.

# E

### EDUCATION, ENGINEERING

**Industries and.** What Our Engineering Colleges Owe Our Industries. Robertson Matthews. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 155-158. More character-building, even at expense of specialized training, urged to supply industry with leaders who have human touch.

### ELECTRIC CONDUCTORS

See ALUMINUM, Electric Conductors.

### ELECTRIC DRIVE

**Machine Tools.** Standardizing Motors for Tools. H. R. Weedon. Iron Trade Rev., vol. 68, no. 8, Feb. 24, 1921, pp. 555-557, 3 figs. Urges cooperation between motor manufacturers and machine-tool makers in securing possible application of general types of electric motors to machine tools. Paper read before Nat. Machine Tool Builders' Assn.

**Mounting Motors.** Mounting Motors to Afford Convenience. J. S. Thomas. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 594-597, 3 figs. Methods of mounting motors to increase free space in shop. Typical installations.

**Paper Machines.** Automatic Speed Control for Sectional Paper Machine Drive. Stephen A. Staege. Elec. Jl., vol. 18, no. 3, Mar. 1921, pp. 78-82, 5 figs. Schematic plan and wiring diagram of Westinghouse system of sectional individual motor drive.

**Rubber Industry.** The Application of Electric Power to the Rubber Industry. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 1, Jan. 1921, pp. 35-47. Possibilities of electric power. Application of 40-degree and 50-degree motors. Steam versus electrically heated drying ovens. Steam versus electric heat treatment of vegetable compounds.

**Textile Mills.** Continental Practice in the Electrical Driving of Textile Factories. W. Dundas Fox. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 165-168, 6 figs. Experiments with electric drive at works of Max Schorch & Co., Germany.

Modern Methods of Driving Machines in Jute Manufacture. T. Woodhouse and P. Kilgour. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 159-165, 9 figs. Advantages of electric drive.

Some Considerations in the Application of Electricity to Textile Mills. J. T. Randles. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 153-156, 6 figs. Estimates of power requirements.

The Individual Electric Drive. Frank Nasmith. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 157-159, 6 figs. Developments in application of electric drive in textile mills in U. S.

The Individual Gear Drive for Heavy Looms. G. F. Sills. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 150-153, 8 figs. Typical installations.

The Use of Gears and High Speed Motors in Textile Mills. George S. Sharman. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 168-171, 6 figs. Practice in English mills.

**Tinplate Mills.** Electricity in the Tinplate Industry. L. Rothera. English Elec. Jl., vol. 1, no. 5, Jan. 1921, pp. 190-198, 10 figs. Typical installations and records of their operation.

### ELECTRIC FURNACES

**Héroult.** First Heat From Naval Electric Furnace. Iron Age, vol. 107, no. 10, Mar. 10, 1921, pp. 617-619, 2 figs. Forty-ton Héroult furnaces operated by U. S. Naval Ordnance plant at So. Charleston, West Va., for refining and finishing steel for gun forgings, armor plate, armor piercing projectiles, and other high-grade miscellaneous forgings.

**Iron Founding.** Cost of Synthetic Gray Iron Low. R. C. Gosrow. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 242-243. Tables giving cost of electrically melted gray iron produced from iron and from steel.

Electric Furnace Improves Gray Iron. Richard Moldenke. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 216-218. Sulphur lowered by treating cupola metal or melting direct on basic bottom. Paper read before Am. Inst. Min. & Metallurgical Engrs.

The Electric Furnace in the Iron Foundry. Richard Moldenke. Min. & Metallurgy, no. 170, Feb. 1921, p. 32. Advantages of basic-hearth electric furnace. (Abstract.)

**Steel Manufacture.** Electric Furnace for High-Speed Steel. Iron Age., vol. 107, no. 11, Mar. 17, 1921, pp. 691–692. Newkirk furnace of two tons capacity, with graphite electrodes and specially constructed bottom electrode.

**ELECTRIC LOCOMOTIVES**

**German.** Cars for the Electric Operation of the Berlin Railways (Die Fahrzeuge für den elektrischen Betrieb der Berliner Bahnen), H. Wechmann. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 7, Feb. 12, 1921, pp. 170–174, 14 figs. The locomotive of the German General Electric Co. (AEG) is driven by a series commutator motor of 450 to 460 kw. capacity at speeds of 36 to 60 km. per hr.; weight on driving axle, 17 tons. Notes on recent trial operation of short-train with passenger locomotive of the Siemens-Schuckert Works (SSW); each short has two locomotives each equipped with two motors of 260 kw. capacity.

**ELECTRIC RAILWAYS**

**Operation.** The Use of Helpers in Electric Train Operation, W. F. H. Hamilton. Ry. Age, vol. 70, no. 8, Feb. 25, 1921, pp. 455–458, 2 figs. Speed-tractive effort curves on resistance for electric freight locomotives used on Chicago, Milwaukee & St. Paul.

**ELECTRIC WELDING**

**Machines.** Electric Welding. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 105–109, 18 figs. Methods and machines employed. Tests of welds.

**ELECTRIC WELDING, ARC**

**Foundry Equipment.** Arc Welding Equipment in the Foundry, W. W. Reddie. Elec. Jl., vol. 18, no. 3, Mar. 1921, pp. 96–99, 10 figs. Equipment for cutting heavy risers and sink heads from steel or iron castings or for filling blow holes of castings.

**Metal Deposition.** Phenomena of Arc Welding, O. H. Eschholz. Thirty-ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 8, pp. 59–71, 16 figs. Discussion of metal deposition, fusion and arc stability during electric welding.

**Studding.** Studding for Arc Welding, C. J. Holslag. Welding Engr., vol. 6, no. 2, Feb. 1921, pp. 25–28, 6 figs. Studding is used where weld is in such position that parts are not free to align themselves to contracting strains which result during cooling. Paper read before Metropolitan Section, Am. Welding Soc.

**Tests.** Solving Some Arc Welding Problems, A. M. Candy. Foundry, vol. 49, no. 5, Mar. 1, 1921, pp. 179–185, 19 figs. Experiments on strength of welds, current values under varied conditions and rates of cutting different materials. Paper read before Am. Foundrymen's Assn.

**EMPLOYMENT MANAGEMENT**

**Interviewing Applicants.** Interviewing for Selection, Earl B. Morgan. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 159–164. Qualifications required for interviewing successfully.

**Selection of Employees.** Hiring and Placing Men. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 705–706. Methods followed at works of Am. Rolling Mill Co.

**ENGINEERS**

**Registration.** The Licensing of Engineers. Min. & Sci. Press, vol. 122, no. 9, Feb. 26, 1921, pp. 297–298. Bill has been introduced in Montana Legislature proposing to create State Board of Engineering Examiners for purpose of licensing engineers. Article gives report on bill prepared by committee of Montana Section, Am. Inst. Min. & Metallurgical Engrs. Committee are adverse against passing of bill on ground that it is not necessary and that it will impose burden in time and money on engineers.

**Remuneration.** Incomes in Engineering Profession Compared with Others. Eng. News-Rec., vol. 86, no. 9, Mar. 3, 1921, p. 387, 2 figs. Iowa Engineering Society investigation of net income of doctors, lawyers and dentists indicates engineers low.

**EVAPORATORS**

**Power Test Code.** Test Code for Evaporating Apparatus. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 184–187. Preliminary draft of third of series of nineteen codes in preparation by Am. Soc. Mech. Engrs. Committee on power test codes. Code is intended primarily for apparatus heated by steam such as vacuum pans, or single and multiple-effect evaporators.

**EXECUTIVES**

**Qualifications.** Getting Executive Leadership, W. R. Basset. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 492–496. Danger of over-organization. One-man versus committee form of control. Advantages of competitive decentralization.

**EXHAUST STEAM**

**Utilization of.** Power from Exhaust Steam. Power Plant Eng., vol. 25, no. 6, Mar. 15, 1921, pp. 303–307, 10 figs. Installation of turbo-generators driven by exhaust steam at plant of Western Drop Forge Co., Marion, Ind.

# F

**FACTORIES**

**Layout.** Plant of The James Leffel & Co. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 253–257, 10 figs. Layout of plant manufacturing water turbines generates steam for power, light and heat.

**Reinforced-Concrete.** Extension to Dunlop Tire Co.'s Plant, Toronto. Can. Engr., vol. 40, no. 9, Mar. 3, 1921, pp. 259–263, 9 figs. Flat-slab reinforced concrete construction. Four-way system and hooped interior columns.

**FACTORY MANAGEMENT**

See INDUSTRIAL MANAGEMENT.

**FANS, CENTRIFUGAL**

**Performance.** Centrifugal Fans or Blowers, Their Performance and Functions, Fred R. Still. Jl. Engrs. Club of Phila., vol. 38, no. 194, Feb. 1921, pp. 72–76. Notes on design, performance and application.

**Steel Works.** Fatigue and Efficiency in an Iron and Steel Works, H. M. Vernon. Eng. and Indus. Management, vol. 5, no. 7, Feb. 17, 1921, pp. 201–208, 5 figs. Data compiled by British Ind. Fatigue Research Board.

**FERROALLOYS**

**Iron-Nickel.** Iron- Nickel Alloys, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 375–378, 7 figs. Properties and behavior of iron-nickel alloys.

[See also FERROMANGANESE; FERROSILICON.]

**FERROMANGANESE**

**Manufacture in Electric Furnace.** Manufacture of Ferromanganese in the Electric Furnace, Robert M. Keeney and Jay Lonergan. Min. & Metallurgy, no. 170, Feb. 1921, pp. 30–31, 2 figs. Electric-furnace production of ferromanganese in 1920 amounted to 10,000 tons. There are now installed 33 electric furnaces of from 350 kva. to 5000 kva. capacity with total installed transformer capacity of 58,000. (Abstract.)

**FERROSILICON**

**Properties.** Influence of Silicon Upon the Properties of Ferrosilicon, A. T. Lowzow. Chem. & Metallurgical Eng., vol. 24, no. 11, Mar. 16, 1921, pp. 481–484, 9 figs. Investigation of samples of ferrosilicon containing from 49.1 per cent to 77.46 per cent silicon. Physical and chemical properties were determined. Translated from Tidskrift for Kemi.

**FITS**

**Forced.** Chart of Pressures for Forced Fits. Machy. (London), vol. 17, no. 439, Feb. 24, 1921, p. 648, 1 fig. Chart for determining pressure required to assemble parts having forced fit. Computed from standard formulas.

**FLAME PROPAGATION**

**Closed Cylinder.** The Nature of Flame Movement in a Closed Cylinder, C. A. Woodbury, H. A. Lewis and A. T. Canby. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 209–218, 21 figs. Experimental work undertaken to determine characteristic flame movement of automobile fuels and physical and chemical properties which influence it. Theory is developed that arrests occurring in mixture fired without turbulence and consequent vibrations observed in burning gases are due to high density developed in gases ahead of flame front. Knock is explained by auto-ignition of high density gases ahead of flame front.

**FORGING**

**Hydraulic-Press Operations.** Hydraulic Forge Press Operations. Am. Mach., vol. 54, no. 11, Mar. 17, 1921, pp. 467–469, 3 figs. Data on work required for punching operation. Examples of forging various types of shells and tubes.

**FOUNDING**

**Research.** The Value of Scientific Research to Iron Founding, J. G. Pearce. Foundry Trade Jl., vol. 23, no. 234, Feb. 10, 1921, pp. 123–124. Experience of British Cast Iron Research Assn.

**FOUNDRIES**

**Electrically Operated.** Foundry is Electrically Operated, H. E. Diller. Iron Trade Rev., vol. 68, no. 8, Feb. 24, 1921, pp. 559–563, 8 figs. Current is utilized for melting furnace charges, annealing castings and for baking molds and cores. Annealing operation is intermittent. How light steel castings are made.

**Layout.** Types of Foundry Buildings. Foundry Trade Jl., vol. 23, no. 236, Feb. 24, 1921, pp. 170–171, 1 fig. Suggested layout for foundries.

**Waste Reclamation.** The Reclamation of Metals from Foundry Waste, J. P. Norrie. Can. Chem. & Metallurgy, vol. 5, no. 3, Mar. 1921, pp. 77–79, 3 figs. Reclaiming and smelting process of Rome Brass & Copper Co., Rome, N. Y.

**FUELS**

**Industrial Uses.** Form Value of Energy in Relation to Its Production, Transportation and Application, Chester G. Gilbert and Jos. E. Pogue. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 139–144, 2 figs. Factors covering selection of fuel for industrial heating. Comparative cost per B.t.u. at unit prices for bituminous and anthracite coal, natural gas, city gas, oil fuel, kerosene oil, gasoline and electricity.

**Liquid and Gaseous from Coal.** Coal as a Future Source of Oil Fuel Supply, Arthur Duckham. Jl. Instn. Petroleum Technologists, vol. 7, no. 25, Jan. 1921, pp. 3–12 and (discussion), pp. 13–26. Scheme for manufacture of liquid and gaseous fuels from coal is suggested which involves total gasification of coal in one vessel, and condensation and recovery of volatiles in liquid form, distillation being carried out at such temperatures and in such manner that minimum of cracking takes place.

**Thermalene.** New Fuel. Power House, vol. 14, no. 4, Feb. 20, 1921, p. 29. Mixture of acetylene and vaporized oil named thermalene, consisting of alternate layers of calcium carbide and crude oil absorbed in sawdust.

[See also AUTOMOBILE FUELS; COAL; LIGNITE; OIL FUEL; PEAT; PULVERIZED COAL; WATER GAS.]

**FURNACES, BOILER**

**Rotating-Hearth.** A New Type of Mechanical Furnace—The Rotating Hearth Romanet Furnace (Un nouveau type de foyer méchanique: la grille à sole tournante), A. Colomb. Chaleur et Industrie, vol. 2, no. 1, Jan. 1921, pp. 27–34, 7 figs. Fire grate is circular and rotates continuously in horizontal plane.

**FURNACES, FORGING**

**Gas-Fired.** The Application of Gas Fuel to Forging. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 703 and 745–746. Requirements for satisfactory forging-furnace fuel. Comparison of gas with oil and coal.

**Siemens.** Small Forge Furnace of Regenerative Type, F. J. Denk. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 107–108 and 111, 4 figs. European progress in design of Siemen's regenerative type of forging furnace.

**FURNACES, HEAT-TREATING**

**Car vs. Car-and-Ball Type.** Car Type and Car-and-Ball Type Furnaces. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 112–119, 9 figs. Factors determining selection of type of heat-treating furnace.

**FURNACES, HEATING**

**Gas-Burning.** The Possibilities of Gaseous Heating, W. Newton Booth. Gas Jl., vol. 153, no. 3011, Jan. 26, 1921, pp. 223–227, 4 figs. Data on efficiency of gas-burning furnaces. Paper read before London & Southern District Junior Gas Assn.

**Stoker-Fired.** Stoker Fired Heating Furnace Installation, Nelson G. Phelps. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 123–126, 7 figs. Data on performance of heavy-duty plate and angle-heating furnaces installed by New York Shipbuilding Corporation.

**FURNACES, INDUSTRIAL**

**Gas-Fired.** Gas Furnaces for Melting Non-Ferrous Metals, M. A. Combs. Chem. & Metallurgical Eng., vol. 24, no. 12, Mar. 23, 1921, pp. 515–516, 1 fig. Economical comparison of gas-fired furnaces with electric furnaces and oil-fired furnaces.

# G

**GAGES**

**Block.** New Precision Measuring Device. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 657–658, 2 figs. Device for measuring within hundred-thousandth part of an inch by use of only six precision measuring blocks, designed by B. M. W. Hanson, Hartford, Conn.

**Interference Bands.** The Hilger Interference Gauge. Engr., vol. 131, no. 3398, Feb. 11, 1921, p. 157, 3 figs. Shows with certainty differences of 0.00001 in. and permits estimation of differences of 0.000001 in.

**GAS**

**Industrial Uses.** Conserving Coal through the Use of Gas, W. A. Ehlers. Coal Age, vol. 19, no. 9, Mar. 3, 1921, pp. 397–400, 3 figs. Elimination of waste through easy regulation and control of heat within narrow limits is cited as advantage of gas over coal for industrial uses.

**GAS MANUFACTURE**

**Dayton Process.** The Dayton Process, F. C. Binnall. Jl. Indus. & Eng. Chem., vol. 13, no. 3, Mar. 1921, pp. 242–246, 5 figs. Air-oil gas process in which partial combustion of certain constituents of oil takes place within retort or reaction chamber itself, thus supplying internally all heat necessary for thermal decomposition of hydrocarbons.

**Mixing Various Coals.** Mixed Coal Experiments, Wm. C. Butterworth. Gas Rec., vol. 19, no. 5, Mar. 9, 1921, pp. 11–13. Tests of mixing various coals for gas making. Scheme has been developed to improve quality of coke and reduce coal costs.

**GAS TURBINES**

**Holzwarth.** A New Gas Turbine. Engr., vol. 131, no. 3398, Feb. 11, 1921, pp. 143 and 145. Resumption at works of Thyssen & Co. of experiments with gas turbine invented by H. Holzwarth, described in Engr., Dec. 8, 1911 and Jan. 5, 1912. Tests are being directed to obtaining of more economical pressure of exploding gas, and it is reported that they have been largely successful in so far as effective pressure of 170 lb. to 200 lb. per sq. in. is now obtained, as against 70 lb. to 85 lb. per sq. in. formerly.

**GASOLINE**

**Production in United States.** Quality of Gasoline Marketed in the United States, H. H. Hill and E. W. Dean. Dept. of Interior, Bur. of Mines, bul. 191, 1920, 275 pp., 22 figs. Production in U. S. has increased approximately 7,000,000 bbl. for calendar year of 1918. Quantity of crude oil handled in refineries has increased from 67,000,000 bbl. in 1904 to 326,000,000 bbl. in 1918. Yield of gasoline 42-gal. bbl. of crude oil has increased from 413 gal. in 1904 to 11 gal. in 1918.

**GEAR CUTTING**

**Machine for.** Machine for Cutting Small Spur or Bevel Gears. Machy. (London), vol. no, 17. 439,

Feb. 24, 1921, pp. 647–648, 3 figs. Knee-type horizontal machine built by T. Ratcliffe, Manchester, England.

Reinecker Turbine Reduction-Gear Hobbing Machines. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 416–417, 4 figs. Three large German mcahines for hobbing gears up to 19½ ft. in diameter. Traversing hob used.

**Rapid.** Some Examples of Fast Gear Cutting, S. A. Hand. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 503–504, 4 figs. Practice at shop of Gould & Eberhardt, Newark, N. J.

### GEARS

**Bevel.** Generating Bevel Gears, H. E. Kitchen. Machy. (London), vol. 17, no. 440, Mar. 3, 1921, pp. 669–670, 4 figs. Attachment manufactured by Matterson, Ltd., England, for generating bevel gears on shaping machine.

**Inspection.** Proposed Methods of Automotive Gear Inspection. Automotive Industries, vol. 44, no. 11, Mar. 17, 1921, pp. 609–610. Gear Makers' Assn. developing standard practice for inspection of their product. Size of hole, wear of gages, tapered holes, keyways, tooth bearing, splined shafts and methods of test are some of items considered.

**Involute.** The Involute Gear, Francis W. Shaw. Machy. (London), vol. 17, no. 438, Feb. 17, 1921, pp. 617–618, 10 figs. Fisher segmental involute tooth.

The Maag System of Gearing. Machy. (Lond.), vol. 17, no. 437, Feb. 10, 1921, pp. 575–581, 13 figs. System developed by Max Maag, Zurich. Standards for pitches, relations between addenda and dedenda and pressure angle are subsidiary, that is, any pitches are possible.

**Spiral.** Chart for Selecting Spiral Gears, C. W. Mapes. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 569–570, 1 fig. Chart developed to aid in selecting and calculating spiral gears with shafts at right angles to each other.

### GRINDING

**Cylindrical.** Cylindrical Grinding in 1920, W. H. Chapman. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 173–176, 2 figs. Study of laws involved in cylindrical grinding and analysis of grinding action both for draw-in cuts and traversed cuts. Formulas are derived for wheel wear in terms of known variables such as grain size of wheel, work speed, wheel speed, feed, etc. Production costs are also discussed as well as factors that should be considered in securing highest possible grinding efficiency.

**Diamonds.** Diamonds for Industrial Purposes, Maurice S. Dessau. Abrasive Industry, vol. 2, no. 1, Jan. 1921, pp. 8–9, 8 figs. Machine and processes for grinding diamonds.

**Dust Removal.** Reducing Grinding Hazards. Abrasive Industry, vol. 2, nos. 2 and 3, Feb. and Mar., 1921, pp. 37–41, 9 figs., and 101–105, 8 figs. Constant inhalation of abrasive dust causes serious pulmonary affections. Causes of excessive dust and its disposal are explained. Attention to work rests, it is claimed, will eliminate many accidents.

## H

### HANDLING MATERIALS

**Factories.** Intra-Factory Transportation, L. R. Clapp. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 195–197. Practice of Ford Motor Co.

Monorail System in German Shell Plant, Hubert Hermanns. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 117–119, 22 figs. Overhead trolley system for transportation of shells.

Putting the Factory Floor on Wheels. Factory, vol. 26, no. 4, Feb. 15, 1921, pp. 475–479, 18 figs. System of handling materials installed in plant of Automatic Electric Washer Co.

**Railways.** Problems of Handling Material and Freight on Railroads, Charles N. Winter. New England Railroad Club, Feb. 8, 1921, pp. 289–323. Equipment used.

### HANGARS

**Reinforced-Concrete.** Reinforced Concrete Hangars for Housing of Two Dirigible Balloons at Lucon, France (Hangar enbéton armé pour deux dirgieables à Lucon (Vendee), Ch. Dantin. Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 145–148, 7 figs. Dimensions: Length, 220 meters; width, 109.6 meters; total height, interior, 53 meters.

**Wire-Rope Roof.** Use of Wire Rope for the Construction of Work Shops and Aircraft Hangars with Suspension Roof (L'application des cable à la construction d'ateliers et de hangars pour avions ou dirigeables, à toiture suspendue), G. Leinekugel Le Coco, Génie Civil, vol. 78, no. 10, Mar. 5, 1921, pp. 205–211, 20 figs. partly on supp. plate. Typical installations at Cherbourg, France, and at Karouba, Tunis. Considerations of design of such structures.

### HEALTH

**Industrial.** Health Service in Industry. Nat. Indus. Conference Board, report no. 34, Jan. 1921, 61 pp., 2 figs. Survey of developments in organization of medical department in industries, and discussion of method of procedure which have been applied advantageously in individual establishments.

### HEATING, ELECTRIC

**Advantages.** Electric Heating and the Importance of Its Developments in France (Le chauffage électrique et les advantages de son développement en France). Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 148–151, 2 figs. Economic comparison of electric heating with other heating processes. Survey of developments in industrial electric heating in U. S., Canada, Scandinavian countries, Switzerland, etc.

**Household Uses.** Thermal Characteristics of Electric Ovens and Hot Plates. Engineer, vol. 131, no. 3399, Feb. 18, 1921, pp. 176–177. Tests at National Physical Laboratory, England, on efficiency of hot plates for roasting, baking, frying and boiling.

### HEATING, HOT-AIR

**Research.** Progress Report of Committee on Furnace Heating, A. C. Willard and A. P. Kratz. Jl. Am. Soc. Heat & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 124–132, 4 figs. Proposed furnace-testing codes for both pipeless and piped furnace systems as developed in warm-air furnace research work at University of Illinois.

### HEATING, HOT-WATER

**Forced-Circulation System.** Forced Hot-Water Circulation Heating System, Girard Estate, Philadelphia, Robert Hughes. Jl. Am. Soc. Heat & Vent. Engrs., vol. 27, no 2, Mar. 1921, pp. 107–108, 7 figs.

### HEAVY-OIL ENGINES

**Ingersoll-Rand.** A New Development of the Heavy Oil Engine, F. A. McLean. Power House, vol. 14, no. 4, Feb. 20, 1921, pp. 26–29, 4 figs. Ingersoll-Rand, Price Rathbun type.

### HELICOPTERS

**Experimental.** A Series of Flights Effected with Helicopter on the 15, 28 and 29 of Jan. 1921 (Une série de vols en helicoptère libre monté effectués les 15, 28 et 29 janvier 1921), Etienne OEhmichen. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 7, Feb. 14, 1921, pp. 366–368. Apparatus has two propellers about 21 ft. in diameter, rotating in opposite directions. Horsepower of engine is 25. In experiments helicopter was raised vertically up to height of 10 ft.

**Military.** A Helicopter for Military Purposes. Sci. Am., vol. 124, no. 9, Feb. 26, 1921, p. 173, 1 fig. Pescara helicopter being tried by French Military Commission. Each of two propellers comprises six spokes which carry wings of biplane design. Propellers revolve at 200 r.p.m.

### HOBBING MACHINES

See GEAR CUTTING, Machines for.

### HOISTING ENGINES

**Mine.** World's Largest Hoisting Engines, R. C. Demary. Nat. Engr., vol. 25, no. 3, Mar. 1921, pp. 108–111, 3 figs. Engines at Michigan mine 5300 ft. deep. Four steam cylinders, 36 in. x 72 in. driving 36-ft. diameter conical drum.

### HOISTS

**Electrically Operated.** Marine Railways, C. B. Connely. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 240–243, 8 figs. Typical installations of electric hoists at American drydocks.

**Skip.** Skip Hoisting for Coal Mines, Andrews Allen and John A. Garcia. Min. & Metallurgy, no. 170, Feb. 1921, pp. 35–36. Advantages of skip hoisting are: Hoisting capacity capable of taking care of all coal and rock that can be mined; smaller shaft; and large ratio of lading to gross weight.

Why Some Operators are Substituting Skips for Cages in the Hoisting of Coal, Andrews Allen and John A. Garcia. Coal Age, vol. 19, no. 11, Mar. 17, 1921, pp. 485–489, 4 figs. Modifications in design necessary where large coal must be produced. Paper read before Am. Inst. Min. & Metallurgical Engrs.

### HOSE COUPLINGS

**Air Brakes.** Repairing Air-Brake Hose Connections, J. V. Hunter. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 377–378, 6 figs. Pneumatic devices used at Decatur car shops of Wabash Railway Co.

### HOUSING

**Concrete Dwellings Ltd., Westminster.** The "C. D. L." System of Concrete Construction. Concrete & Constructional Eng., vol. 16, no. 2, Feb. 1921, pp. 118–123, 7 figs. Solid walls, or hollow walls with concrete ties are constructed by means of traveling mold. In case of hollow-wall mold is provided with core; if solid wall is desired, core is absent.

**Hayes, England.** Concrete Cottage Building. Hayes Housing Scheme. Concrete & Constructional Eng., vol. 16, no. 2, Feb. 1921, pp. 105–111, 9 figs. Houses erected with solid concrete walls and timber shuttering.

**Industrial, U. S.** Housing by Employers in the United States, Leifur Magnusson. U. S. Dept. of Labor, Bur. of Labor Statistics, no. 263, Oct. 1920, 283 pp., 111 figs. Representative examples of manufacturing towns and mining communities.

### HYDRAULIC TURBINES

**Water Measurement.** New Method of Water Measurement in Efficiency Tests of 37,500-hp. Turbines, N. R. Gibson. Power, vol. 53, no. 12, Mar. 22, 1921, pp. 452–458, 17 figs. Efficiency tests of three units in station of Niagara Falls Power Co. are described with particular reference to application of Gibson method and apparatus for measuring flow of water in penstocks. Paper read at joint meeting of Engrs. Club of Phila. & Phila. Sections of Am. Soc. Civil Engrs., Am. Inst. Elec. Engrs. & Am. Soc. Mech. Engrs.

New Method of Water Measurement in 37,500-hp. Turbine Tests. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 591–593, 8 figs. Discharge is measured by pressure developed in penstock when turbine gates are closed. Method has been applied at Niagara Falls.

**Wheel for.** New Type of Wheel for Hydraulic Turbine (Tipo nuevo de rueda para turbina hidráulica), Forrest Nagler. Ingenieria Internacional, vol. 5, no. 4, April 1921, pp. 206–208, 2 figs. Four-bladed propeller rotating at 50 r.p.m.

### HYDROELECTRIC PLANTS

**Austria.** The Construction of the Power Station at Waterfalls on the Mur River (Austria) (Der Bau des Murfallwerkes), Otto Judtmann. Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, nos. 1–2, Jan. 14, 1921, pp. 5–6, 4 figs. Construction details of nearly completed light and power station begun in 1919.

**Automatic.** Automatic Hydroelectric Plants for Power and Lighting. T. A. E. Belt. Elec. Rev. (Chicago), vol. 78, no. 11, Mar. 12, 1921, pp. 417–420, 5 figs. Types of control and regulating equipment available for use with stations operating without individual attendants.

**Bavaria.** Hydroelectric Development in Bavaria (Ueber den Ausbau der Wasserkräfte in Bayern), Phillip Forchheimer. Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, nos. 1–2, Jan. 14, 1921, pp. 1–3. Summary of projects to be financed by State and private industries, totaling 223,700 hp., which is greatly in excess of total (112,838 hp.) already developed.

**California.** Hydro-Electric Plant Built in 15 Months, R. C. Starr. Elec. World, vol. 77, no. 9, Feb. 26, 1921, pp. 461–474, 8 figs. Methods that were employed to hasten 50,000-hp. Kerckhoff development (California) which was undertaken to relieve power shortage resulting from postponement of construction during war period.

**Economical Operation.** Note on a System for Accumulation of Energy Which Permits more Economical Operation of a Hydroelectric Central Station (Di un sistema di accumulazione d'energia, per una migliore utilizzazione delle centrali idroelectriche), Alfredo Mauceri. Elettrotecnica, vol. 8, no. 4, Feb. 5, 1921, pp. 73–75. Thermal electric installation at Olten, Switzerland.

**England.** The Lochaber Hydro-Electric Scheme. Engr., vol. 131, no. 340, Mar. 4, 1921, pp. 226–227, 2 figs. Scheme for production of from 70,000 to 75,000 hp. continuously.

**Muscle Shoals.** Completion of Muscle Shoals Plant Urged. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 587–590, 6 figs. Proposed dam and power house is structure 4200 ft. long situated on Tennessee River above Florence, Ala. As part of installation there will be locks providing for navigation past dam with total lift of 90 ft. above level of proposed lower pool.

Hydro-Electric Project at Muscle Shoals, A. S. McBride. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 422–424, 3 figs. Five-hundred-thousand-horsepower project at Wilson Dam, to supply power at 4 mills per kilowatt-hour for continuous, and 1.2 mills for surplus, energy.

**North Wales.** Actual and Projected Water Power Developments in North Wales, John B. C. Kershaw. Engr., vol. 131, no. 3400, Feb. 25, 1921, pp. 195–198, 10 figs. Developments contemplated will furnish an additional 35,000 kw. at 34,600 volts.

**Norway.** The Hydro-Electric Power Scheme at the Nore Falls. Engineering, vol. 11, no. 2879, Mar. 4, 1921, pp. 248–249, 5 figs. Developments by Norwegian government of hydroelectric power scheme near Christiania. (To be continued.)

**Pressure Shafts.** The Calculation of Pressure Shafts (Zur Berechnung von Druckschächten), J. Büchi. Schweizerische Bauzeitung, vol. 77, nos. 6, 7 and 8, Feb. 5, 12 and 19, 1921, pp. 61–63, 73–76 and 88–91, 11 figs. Notes on investigation of an Austrian pressure shaft through rock, dealing with general construction procedure and the separate problems; calculation of influence of the internal water pressure; influence of contraction of the concrete, and of temperature; insufficient laying on of concrete; longitudinal and round joints; drainage of pipe; pressure of soil; rust deterioration; comparison of costs.

**Weedon, P. Q.** Hydro-Electric Plant at Weedon, P. Q., for City of Sherbrooks. Contract Rec., vol. 35, no. 10, Mar. 9, 1921, pp. 229–230, 4 figs. Plant will develop 4000 hp. and deliver energy at 50,000 volts along transmission line 28 miles long.

[See also WATER POWER.]

## I

### ICE PLANTS

**Electrically Operated.** Electrically Operated Ice Plants, Reginald Trautschold. Refrigerating World, vol. 56, no. 3, Mar. 1921, pp. 12–13. Development of electric drive for ammonia compressors.

### INDUSTRIAL MANAGEMENT

**Administrative Research.** Industrial Research in the Art of Man Management, Erwin H. Schell. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 364–367. Administrative research recommended for standardization of policies. Questionnaire suggested.

**Chemical Plants.** Taking Industrial Chemistry Into Partnership—I, Frederic Dannerth. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 151–154. Standard practice for chemical industry process management.

**Instruction Sheets.** Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 8, Jan. 25, 1921, p. 58. Proposal of the Committee for Economic Production for

instruction sheet for the ordering and delivery of machine tools.

**Legislation.** The Future of Industrial Management, F. M. Lawson. Jl. Royal Soc. of Arts, vol. 69, no. 3559, Feb. 4, 1921, pp. 164–171 and (discussion) pp. 171–175. Discusses enacting of future legislation for promotion of industrial peace.

**Planning Departments.** Practical Organization Principles, G. Sumner Small. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 183–186. Principles underlying practical organization of industrial departments.

**Production Systems.** Color Cycle Production Control, Carle M. Bigelow. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 168–170, 4 figs. Method adopted in knitted underwear plant.

Controlling the Flow of Production, H. K. Hathaway. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 175–179, 5 figs. How to keep track of split or broken lots on single route-sheet.

Increasing Production by a Rational Piece-Work System, John C. Spence. Machy. (N. Y.), vol. 27, on. 6, Feb. 1921, pp. 519–520. Experiences of manufacturers with piece-work system.

Modern Production Methods—XV, W. R. Basset. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 398–402, 7 figs. Forms for accounting for supplies.

Production Methods of Rolls-Royce Plant. Iron Age, vol. 107, no. 9, Mar. 3, 1921, pp. 555–559, 4 figs. Experience of automobile factory built in America along lines of English works.

System for Production Control. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 647–650, 8 figs. Methods employed in plant of Am. Multigraph Co., for recording progress of work.

**Safety.** Safety Organization in Machine Shops. Eng. & Indus. Management, vol. 5, no. 8, Feb. 24, 1921, pp. 232–233. Safety organization of typical firm.

Safety Methods Applied in the Ryerson Steel-Service Plants. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 351–354, 6 figs. Outline of general organization for safety promotion in plants and of results leading to better relationship between management and workers and to ultimate reduction of plant-operating costs and higher efficiency.

**Shop Methods.** Sharpening Up Dull Periods. Factory, vol. 26, no. 6, Mar. 15, 1921, pp. 718–723. From results of questionnaire to 325 plants asking them for description of their practices in slack times.

**Storing Materials.** Stores Engineering, M. T. Montgomery. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 10, Jan. 1921, pp. 641–673 and (discussion) pp. 674–682, 26 figs. Storekeeping practice of Pittsburgh Railways Co.

**Systems.** Idealism as a Factor in Management, Herbert Rollin White. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 165–167. Application of "golden rule" in industrial management. Examples of successful management.

**Toolroom Organization.** A Tool System That Speeds Production, William J. Burger. Factory, vol. 26, no. 4, Feb. 15, 1921, pp. 458–460, 6 figs. Toolroom organization of Warner & Swasey Co.

**INDUSTRIAL RELATIONS**

**Department of.** Industrial Relations Departments, James W. Brown. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 229–231. Advantages derived from promoting family spirit in industrial life of employees. Paper read before Am. Foundrymen's Assn.

**Open Shop.** Twin Cities Team for Open Shop, A. J. Hain. Iron Trade Rev., vol. 68, no. 11, Mar. 17, 1921, pp. 762–768. Association organized by St. Paul Manufacturers to coöperate with Minneapolis Citizen's Alliance.

[See also TIME STUDY.]

**Syndical Control, Italy.** Syndical Control of Industries in Iatly (À propos du controle syndical des industries en Italie). Revue générale de l'Electricité, vol. 9, no. 9, Feb. 26, 1921, pp. 289–296. Text of projects submitted to Italian Government by Italian Federation of Intellectual Workers and by Italian General Federation of Industry, together with text of project devised by Italian Government.

**INLAND NAVIGATION**

**Electric Hauling on Canals.** New Systems of Electric Hauling on Canals (Nouveaux systèmes de halage électrique sur les canaux), Ed. Imbeaux. Nature (Paris), no. 2441, Jan. 15, 1921, pp. 33–37, 5 figs. Developments in France.

**INSULATORS, HEAT**

**Tests.** Heat Insulating Properties of Cork and Lith Board, A. A. Porter, J. P. Coulderwood, A. J. Mack and L. S. Hobbs. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 285–286. 4 figs. Tests made in Engineering Experiment Station of Kansas State Agricultural College. Cork board showed heat insulating property approximately 5 per cent greater than lith board.

Relative Heat Conductivities of Some Insulating and Building Materials, James J. Lichtin. Chem. & Metallurgical Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 388, 2 figs. Experimental measurements.

**INTERNAL-COMBUSTION ENGINES**

**Efficiency Determination.** Determination of the Mechanical Efficiency of Internal-Combustion Engines, V. L. Maleev. Gas Engine, vol. 23, no. 3, Mar. 1921, pp. 53–58, 7 figs. Type of brake constructed by writer for testing high-pressure Diesel engine of 140 b.hp.

**Indicator Diagrams.** A High-Speed Engine Pressure Indicator of the Balanced Diaphragm Type, H. C. Dickinson and F. B. Newell. Nat. Advisory Committee for Aeronautics, no. 107, 15 pp., 14 figs. Principle involved is balancing of engine cylinder pressure against measured pressure on opposite sides of metal diaphragm of negligible stiffness. Phase of engine cycle to which pressure measurement corresponds is selected by timing device.

**Two-Stroke.** The Record Two-Stroke Engine. Engr., vol. 121, no. 3402, Mar. 11, 1921, pp. 270–271, 2 figs. Absence of poppet valves is feature of internal-combustion engines manufactured by Record Eng. Co., London. Valves are replaced by arrangement of twin working pistons and piston valve, latter being operated by means of eccentric formed solid with crankshaft and being utilized for distributing explosive mixture to cylinders.

**Water Coolers.** The Heenan Water Cooler. Engineering, vol. 111, no. 2877, Feb. 18, 1921, p. 193, 6 figs. Cooler consists of single casting containing two vertical screens formed of brass or phosphor bronze, metallic wool and placed one behind the other. Water from engine jackets is distributed from troughs on top of cooler over screens through perforated brass plates, and is then recirculated by rotary pump.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; HEAVY-OIL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES; TRACTOR ENGINES.]

# J

**JIGS**

**Manufacture.** Building Jigs and Fixtures on Manufacturing Basis, W. H. Vockell and H. C. Uihlein. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 632–635, 11 figs. Standardization of details to permit production in quantity at reduced cost. Practice of Cincinnati Eng. Tool Co.

Using Compound Slide in Jig and Die Making. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 630–631, 4 figs. How Johansson compound slide is used in toolroom work, especially in laying out of accurately spaced holes.

# L

**LABOR**

**College Movement.** What the Workers Want to Know, William Leavitt Stoddard. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 208–210. Objects and methods of labor college movement.

**Hours of Work.** Practical Experience With the Work Week of Forty-Eight Hours or Less. Nat. Indus. Conference Board, research report no. 32, Dec. 1920, 88 pp. Based on experience of manufacturers extending over varying periods. It was desired to determine whether or not 48 hr. schedule would yield the same, or practically the same, weekly output per worker as previous longer schedule in same plants and under substantially same conditions.

[See also INDUSTRIAL RELATIONS; INDUSTRY.]

**LADLES**

**Stopper.** Proved Design for Ladle Stopper. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 219–222, 3 figs. Means provided for taking care of expansion of sleeve. Taper of bottom sleeve for acid practice.

**LATHE TOOLS**

**Multiple Inserted Cutters.** Efficiency Tests with Tools with Multiple Inserted Cutters (Leistungsversuche mit Stählen mit mehrfacher Schneide), Hermann Brösamlen. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 213–215, 1 fig. Described tests show that by use of profile tools (Jäger tools, patented), an increase in production without increase of means of production can be obtained, due to the combined arrangement of the tools and especially to reduction of the unproductive working period.

**LATHES**

**Bench.** Tools and Methods for Manufacturing Precision Bench Lathes—I, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 668–672, 8 figs. Practice of S. A. Potter Tool & Machine Works, New York City, in manufacture of bench lathes.

**Cadillac.** The Cadillac Vertical Lathe, J. V. Hunter. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 489–491, 5 figs. Semi-automatic compact machine intended for single-purpose work.

**Lead-Screw Variator.** Lathe Lead Screw Variator Device. Iron Age, vol. 107, no. 9, Mar. 3, 1921, pp. 569, 2 figs. Device consists of bracket unit clamped to ways of lathe, lead-screw mechanism and rods connecting variator nut with lathe carriage. Manufactured by Precision & Thread Grinder Mfg. Co., Philadelphia.

**Stud and Bolt.** Automatic Stud and Bolt Machine. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 252, 5 figs. Machine designed for straight forward stud and bolt work. Machine is provided with automatic chuck for machining bolts $1^1/_2$ in. in diameter; range of studs dealt with is from $^1/_2$ in. to $1^1/_4$ in., with maximum length of 9 in.

**Turret.** Obtaining Production on the Vertical Turret Lathe. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 534–540, 18 figs. Application of Bullard vertical turretlathe to machine-shop practice, including typical examples and description of tooling used.

Turret Lathe Applications, J. H. Moore. Can. Machy., vol. 25, no. 6, Feb. 24, 1921, pp. 38–41, 16 figs. Tooling necessary for machining axle housing, motor frame, and piece of work weighing over 600 lb.

**LIGHTING**

**Illumination Standards.** Practical Illumination Design Method and Data, Earl A. Anderson. Elec. Rev. (Chicago), vol. 78, no. 11, Mar. 12, 1921, pp. 411–415, 8 figs. Table giving present standards for illumination for various services. (To be continued.)

**Industrial.** Industrial and Factory Lighting. Jl. Electricity & Western Industry, vol. 46, no. 4, Feb. 15, 1921, pp. 186–187, 4 figs. Investigation in 446 industrial plants brought out that average of approximately 25 per cent of work done is carried on under artificial illumination.

The Human Factor in Industrial Lighting, James R. Cravath. Jl. Electricity & Western Industry, vol. 46, no. 4, Feb. 15, 1921, pp. 181–183, 2 figs. Tests showing effect of improved artificial lighting on output in number of industrial plants.

**LIGNITE**

**Briquetting.** The Manufacture of Lignite Briquettes. Eng. Progress, vol. 2, no. 2, Feb. 1921, pp. 25–28, 7 figs. Description of briquetting factory.

**Drying.** Lignite (Le lignite), Jean C. Verdier. Revue de l'Ingenieur, et Index Technique, vol. 28, no. 1, Jan. 1921, pp. 9–16, 4 figs. Formula and graph for determining quantity of water to be removed by grinding. (Continuation of serial.)

**LOCOMOTIVE BOILERS**

**Insulation.** The Insulation of Locomotive Boilers, Wm. N. Allman. Ry. Rev., vol. 68, no. 10, Mar. 5, 1921, pp. 349–350, 2 figs. Efficiency curves of 85 per cent magnesia lagging.

**LOCOMOTIVES**

**Electric.** See ELECTRIC LOCOMOTIVES.

**European Designs.** Recent Trend in Locomotive Design in Europe. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 189–192, 8 figs. Three-cylinder fast-freight locomotive in operation in English railway, and German internal-combustion mine locomotives.

**Feedwater.** See BOILER FEEDWATER, Treatment.

**Freight, Tests.** Design and Tests of Freight Locomotives on the Pennsylvania Railroad, Lawford H. Fry. Engineering, vol. 111, no. 2877, Feb. 18, 1921, pp. 190–191, 2 figs. Graphs showing speed and drawbar pull of various types. (To be continued.)

**Fuel Consumption.** Train Schedules and Locomotive Fuel Consumption, Edwin Winfield. Can. Ry. & Mar. World, no. 277, Mar. 1921, pp. 124–126, 4 figs. Graphs indicating variation in coal consumed with power exerted.

**Oil-Burning.** Results of Traction Tests of Locomotives Equipped for Burning Oil (Risultati degli esperimenti e delle prove di trazione eseguite con alcune locomotive attrezzate per bruciare la nafta nei forni delle loro caldaie), Alessandro Mascini. Rivista tecnica delle Ferrovie Italiane, vol. 18, no. 5, Nov. 15, 1920, pp. 161–189, 5 figs. Experiments conducted by Italian State Railways. (Concluded.)

**Pulverized-Coal-Burning.** Locomotive Burning Pulverized Coal (L'application du charbon pulverisé aux locomotives). Outillage, vol. 5, no. 4 Jan. 27, 1921, pp. 98–101, 50 figs. Italian locomotives equipped to burn pulverized lignite, also Swedish locomotives with Fuller system for burning pulverized peat.

**Shop Equipment.** Locomotive Shop Equipment on Wheels, J. V. Hunter. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 403–404, 6 figs. Locomotives transferred to repair pits by traveling crane. Time saved by taking portable workbenches and machine tools to work.

**Superheaters, Schmidt.** The New Tender Locomotives of the Danish State Railroad with Narrow-Tube Superheaters (Statsbanernes nye Tenderlokomotiver med Smaarörsoverheder). Ingeniören, vol. 30, no. 1, Jan. 1, 1921, p. 3. Locomotives (switchers) are provided with the Schmidt system of smoke-tube superheaters consisting partly of enlarged and partly of narrow fire tubes.

**LUBRICATING OILS**

**Centrifugal Cleaner.** Centrifugal Oil Cleaner. Oil News, vol. 9, no. 4, Feb. 20, 1921, pp. 21–22, 2 figs. Apparatus under development at McCook Field. Oil is led from oil tanks to inside of bowl which is rotating at 2550 r.p.m. when engine is turning up 1700 r.p.m.

**Dilution.** Dilution of Crankcase Oil, Wm. F. Parish. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 231–237 and 254, 3 figs. Results of tests made on aeroplane engines to determine effect of dilution of crankcase oil. Comparative characteristics of used and reclaimed oil. Paper read before Am. Petroleum Inst.

**Selection.** Friction and Fuel, Wm. N. Berkeley. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 390–392. Comparison of constants of asphalt-base and paraffin-base lubricating oils. Table indicating best uses for different classes of lubricating oils.

# M

**MACHINE SHOPS**

**Layout.** New Plant of the Foote-Burt Company. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 528–530, 6 figs. Features of modern factory planned with view to convenient handling and progressive routing of work.

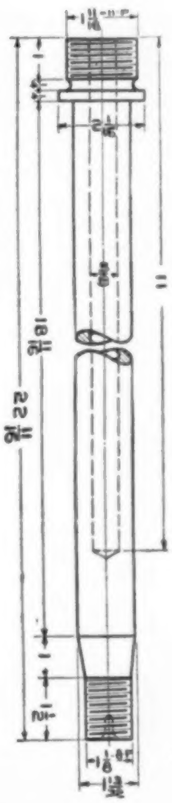
# The Best Production Methods Are the Most Economical

There is only one *best* method in turret lathe practice. Our Engineers are constantly studying and experimenting to reach that best method and keep our turret lathes up to their high standard.

The results of their study and experimenting are yours to apply to your production problems. Just write us and we'll send one of our engineers to consult with you. He may be able to save you considerable money by suggesting a tool or two or perhaps by re-arranging the tools you have. This is part of our service to you.

*Turret Lathes from 4½" x 44"—21" Swing to ⅝" x 4"—10" Swing.*

*A. W. & S. No. 3-A finishes one of these Air Brake Pump Pistons of cold rolled stock every 20 minutes in an eastern railroad shop. This is a difficult railroad job.*



# The Warner & Swasey Company

**Cleveland, U. S. A.**

**NEW YORK OFFICE: Singer Building BUFFALO OFFICE: Iroquois Building BOSTON OFFICE: Oliver Building DETROIT OFFICE: Ford Building CHICAGO OFFICE AND SHOW ROOM: 618-622 Washington Boulevard MILWAUKEE OFFICE: 209 Sycamore Building DAYTON OFFICE: 518 Mutual Home Building INDIANAPOLIS OFFICE: 940 Lemcke Annex**

**Domestic Agents:**

Fulton Supply Company, Atlanta, Ga.
Young & Vann Supply Company, Birmingham, Ala.
Woodward, Wight & Company, New Orleans, La.
Salt Lake Hardware Company, Salt Lake City, Utah.
Smith-Booth-Usher Company, Los Angeles, Calif.
Fred Ward & Son, San Francisco, Calif.
Portland Machinery Company, Portland, Ore.
Hallidie Machinery Company, Seattle, Wash.
Hendrie & Bolthoff Mfg. & Supply Company, Denver, Col.
Peden Iron & Steel Company, Houston, Texas.

**Canadian Agents:**

A. R. Williams Machinery Company, Ltd., Toronto, Winnipeg, Vancouver, St. John.
Williams & Wilson, Ltd., Montreal.

**Foreign Agents:**

Charles Churchill & Company, Ltd., London, Birmingham, Manchester, Bristol, Newcastle-on-Tyne, Glasgow.
Allied Machinery Company, Paris, Turin, Zurich, Barcelona, Brussels.
Wilhelm Sonesson Company, Malmo, Copenhagen, Stockholm, Gothenburg.
R. S. Stockvis en Zonen, Rotterdam.
Benson Brothers, Sydney, Melbourne, Adelaide.
Yamatake & Company, Tokyo, Osaka, Nagoya, Fukuoka, Dairen
McLeod & Company, Calcutta.
Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

**MACHINE TOOLS**

**Duplicating Machines.** The Manufacture of Duplicating Machines. Eng. Production, vol. 2, no. 22, Mar. 3, 1921, pp. 289-294, 16 figs. Manufacturing methods employed in Roneo Works, London.

**German.** German Machine Tools. Eng. & Industrial Management, vol. 5, no. 6, Feb. 10, 1921, pp. 174-175. Report of general meeting of British Machine Tool Trades Assn. giving arguments for and against handling of German machine tools in England.

**Heavy.** Some Examples of Heavy Modern Machine Tools, K. Ehmcke. Eng. Progress, vol. 2, no. 2, Feb. 1921, pp. 33-38, 15 figs. Giant portal-type milling machine with two vertical spindles and four horizontal boring and milling machines; giant milling machine with three double spindles and seven electromotors; lathe with 8.5 ft. height of centers; vertical lathe for turning diameter of 39.4 ft.

**Spacing Tables.** Improved Design of Spacing Table. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 707, 3 figs. Semi-automatic machine manufactured by Cleveland Punch & Shear Works Co.

**Special-Purpose.** Special Machines and Tools in the Chandler Plant. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 565-568, 6 figs. Equipment used by Chandler Motor Car Co., Cleveland, Ohio, for milling crankcases, boring and reaming crankshaft and camshaft bearings, and numerous other operations.

**Variable-Speed Motors for.** Machine Tools and Variable-Speed Motors (Werkzeugmaschine und Reguliermotor), Othmar Pollok. Werkstattstechnik vol. 15, no. 4, Feb. 15, 1921, pp. 81-85, 7 figs. Their use in connection with large and small machine tools. Direct-current versus 3-phase-current variable-speed motors.

**MACHINERY**

**Manufacture.** Building Heavy Machinery. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, pp. 321-325, 6 figs. Works and methods of Hick, Hargreaves, England, manufacturers of locomotives, marine engines, Lancashire and other type boilers, stationary engines of all classes, water turbines and mill-gearing.

**MALLEABLE IRON**

**Experiments.** Experiments in Malleable Iron, F. H. Hurren. Foundry Trade Jl., vol. 23, no. 234, Feb. 10, 1921, pp. 125-128 and (discussion) pp. 136-138, 6 figs. Analyses of samples and photomicrographs.

**Foundries.** Equips for Malleable Jobbing Work, H. E. Diller. Foundry, vol. 49, no. 5, Mar. 1, 1921, pp. 171-175, and 185, 8 figs. Foundry at Temple, Pa., where $2^1/_2$ lb. of castings are annealed with 1 lb. of coal.

**Strength of.** American Malleable Cast Iron—V, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 9, Mar. 3, 1921, pp. 628-631 and 633. Stress-strain diagrams of malleable cast iron in compression and in shear.

**METALS**

**Thermal Capacities.** Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 109-111, 4 figs. Graph showing heat content of pure metals at various temperatures, constructed from figures obtained in experiments conducted by the Society of German Engineers.

**METRIC SYSTEM**

**Arguments Against Adoption in United Kingdom.** Scientific England and the Metric System. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, p. 154. Abstract of report submitted by Metric Committee appointed by conjoint board of Scientific Societies of United Kingdom. It is recommended that British system of units of weights and measures be retained in general use in United Kingdom.

**Arguments Against Adoption in U. S.** The Metric Equivalent Scheme, Frederick A. Halsey. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 665-667, 1 fig. Arguments against contention of T. H. Miller in Machinery 1920 that it is feasible to adopt metric measurements for machines already being manufactured in English units.

**MILLING MACHINES**

**Fixtures.** Milling Machine Methods. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, pp. 330-331, 11 figs. Typical fixtures designed for production milling.

**MOLDING MACHINES**

**Pneulec Electrically Operated.** The "Pneulec" Moulding Machine. Foundry Trade Jl., vol. 23, no. 232, Jan. 27, 1921, p. 76, 1 fig. Electrically operated machine which can simply be placed on firm foundation and connected up to nearest electric supply main; it is said to be possible to obtain between 40 to 210 molds per day.

**Squeezer Machine.** Invents a New Type of Squeezer Machine. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 249-250, 1 fig. Patented machine operated by compressed air.

**MOLYBDENUM STEEL**

**Tests.** A Discussion of Molybdenum Steels, Charles McKnight. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 288-296. Tensile tests of molybdenum steels.

**Uses.** Molybdenum Steels, John A. Matthews. Chem. & Metallurgical Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 395-396. Also Min. & Metallurgy, no. 170, Feb. 1921, pp. 39-40. Development of molybdenum steel in America. Early experiments with this element in complex alloys for tools. Recent successful utilization in mechanical and structural steels of high strength and great adaptability.

**MORTARS**

**Cement, Shrinkage.** Shrinkage of Portland Cement Mortars and Its Importance in Stucco Construction. J. C. Pearson, Eng. & Contracting, vol. 55, no. 8, Feb. 23, 1921, pp. 187-190, 6 figs. Results of measurements on about 200 mortar slabs. Investigation conducted at U. S. Bur. of Standards. Paper read before Am. Concrete Inst.

**MOTOR TRUCKS**

**Farm Service.** Corn-Belt Farmers' Experience with Motor Trucks, H. R. Tolley and L. M. Church. U. S. Dept. Agriculture, bul. no. 931, Feb. 25, 1921, 34 pp., 3 figs. Study of 831 reports from farmers who own motor trucks.

**MOTORSHIPS**

**Steamships vs.** Advantages of Motorships Compared with Steamships. Motorship, vol. 6, no. 3, March 1921, pp. 210-211, 1 fig. Saving in space, which amounts to 30 per cent for machinery alone in favor of Diesel plant; saving of fuel, figures for motorship being about 0.33 lb. per i.hp. per hr., and for geared turbines steamship seldom below 0.990 lb. per i.hp. per hr.; no standby losses in motorships; and less cost for cleaning and repairs in motorship.

# N

**NICKEL**

**Wire.** The Change in the Rigidity of Nickel Wire with Magnetic Fields, William Brown and Patrick O'Callaghan. Sci. Proc. Royal Dublin Soc., vol. 16, no. 8, Aug. 1920, pp. 98-104, 2 figs. Records of measurements. Initial increase in rigidity of nickel was less for alternating than for direct longitudinal magnetic fields, while subsequent decrease was greater for alternating longitudinal fields than for direct fields.

**NICKEL STEEL**

**Tests.** Static and Dynamic Tension Tests on Nickel Steel, J. J. Thomas and J. H. Nead. Min. & Metallurgy, no. 170, Feb. 1921, p. 34. Relation between static and dynamic tension tests as measured by work required to break test specimens slowly in tensile testing machine, and rapidly, by means of falling weight. (Abstract.)

**NOZZLES**

**Diesel-Engine.** Nozzle Design for Diesel Engines—Influence of Air Pressure and Engine Speed, J. A. Wallard. Power, vol. 53, no. 12, Mar. 22, 1921, pp. 469-471, 2 figs. Effect of variable load and speed.

**Losses in.** On the Losses in Convergent Nozzles, A. L. Mellanby and Wm. Kerr. North-East Coast Instn. Engrs. & Shipbuilders (advance paper), 40 pp., 22 figs. Investigation of results given for convergent nozzle types in Pressure Flow Experiments on Steam Nozzles, Proc. Inst. Engrs. and Shipbuilders in Scotland, Nov. 16, 1920, and account of results obtained in further tests on steam nozzles. Empirical formula for total loss at any point along jet within boundary form is developed.

**Tests.** Pressure-Flow Experiments on Steam Nozzles, A. L. Mellanby and William Kerr. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 269-274, 20 figs. Determination of pressure at various points of nozzle by means of "search tube" moved along jet. Paper read before Instn. Engrs. & Shipbuilders in Scotland.

# O

**OIL**

**Distillation.** A New Oil Distilling Process. Petroleum Times, vol. 5, no. 110, Feb. 12, 1921, p. 185. Process of mineral-oil distillation under high vacuum by means of which mineral oils or heavy mineral-oil residues are distilled non-destructively to solid coke. Process was developed by Leo Steinschneider, Bruenn-Koenigsfelder Maschinenfabrik, Czecho-Slovakia.

[See also PETROLEUM.]

**OIL ENGINES**

**Cold-Starting.** Cold-Starting Oil Engine. Gas Engine, vol. 23, no. 3, Mar. 1921, pp. 73-74, 2 figs. Fuel consumption curves of 250 b.hp. twin-cylinder Ruston high-compression oil engine.

**Hot-Bulb.** A Six-Cylinder Hot Bulb Engine. Engr., vol. 131, no. 3400, Feb. 25, 1921, pp. 212-214, 4 figs. Marine engine of 450 b.hp. constructed by Vickers-Peters, Ipswich, England.

**OIL FIELDS**

**Borneo.** The Sanga Sanga Oil Field of Borneo, W. H. Emmons and J. W. Gruner. Eng. & Min. Jl., vol. 111, no. 10, Mar. 5, 1921, pp. 431-432, 2 figs. Production in 1911 was 495,124 tons.

**Exploitation by Shafts and Galleries.** Working Petroleum by Means of Shafts and Galleries, Paul deChambrier. Petroleum Times, vol. 5, no. 111, Feb. 19, 1921, pp. 209-211, 1 fig. Practice at Pechelbronn, Alsace. Economical advantage of method. (Abstract.) Paper read before Instn. Petroleum Technologists.

**OIL FUEL**

**Bunkering Station.** Oil Fuel Bunkering Station at Marseille (Installation d'un dépot de mazout a Marseille). Bulletin technique de Bureau Veritas, vol. 3, no. 2, Feb. 1921, pp. 36-37, 1 fig. Details of discharging and pumping station. English test is given on page 38.

**Burners.** The Fisher Oil Fuel Burner. Engineering, vol. 111, no. 2878, Feb. 25, 1921, p. 225, 4 figs. U. S. Navy design intended to maintain whirling motion of liquid fuel over wide range of consumption.

**Industrial Uses.** Heating by Fuel Oil for Manufacturing Processes, C. C. Hermann. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 199-202. Advantages and limitation of oil fuel for industrial uses, particularly in use in forge-shop and heat-treating furnaces. Methods of purchasing, testing and storing fuel. Example illustrating how air capacity is determined for given service.

**Measurement.** Measurement of Fuel Oil, J. D. Gilman. Mar. Eng., vol. 26, no. 3, Mar. 1921, pp. 234-237. Tables for reducing measurement to standard conditions.

**Specifications.** The Saybolt Furol Viscosimeter, E. W. Dean. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2215, 4 pp. Apparatus employed by Bureau of Mines in determining quality of oil fuel as required by specifications issued by U. S. Navy. Superiority of defining oil fuel in terms of viscosity rather than gravity is concluded from results of inspection work undertaken for U. S. Shipping Board.

**Uses.** Fuel Oil Burning in Various Parts of the World, Andrew F. Baillie. Jl. Royal Soc. of Arts, vol. 69, no. 3563, Mar. 4, 1921, pp. 232-243 and (discussion) pp. 243-246. Survey of uses, and records of comparative tests with coal and oil in similar boilers.

**OIL SHALES**

**Pennsylvania.** See COAL DEPOSITS, Pennsylvania.

**Pyrolytic Distillation.** Plant Design for Hot-Gas Pyrolytic Distillation of Shale, Louis Simpson. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 341-345, 2 figs. Description and plan of 2000-ton-per-day shale-oil plant operating on indirect heating process employing hot gases for conveying reacting heat and resultant oil vapors from pyrolysis of shale.

**Spent Shale, Uses of.** Possible Uses for the Spent Shale from Oil Shale Operations, Kirby Thomas. Chem. & Metallurgy Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 389-390. Uses as fuel, as non-conductor material for electrical applications and as material for making brick.

**Utilization.** Some Items of Investment, Expense, and Profit in Commercial Shale-Oil Production, L. H. Sharp and A. T. Strunk. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2214, 3 pp. Equipment necessary for large-scale commercial utilization of oil shales.

# P

**PEAT**

**Use on Swedish Railways.** Peat Proves Satisfactory Fuel on Swedish Railways. Commerce Reports, no. 46, Feb. 25, 1921, p. 1109. Peat is dried in open air and softest lumps are converted into powder or briquets. Tests have passed experimental stage and Railway Board of Sweden has constructed plant with capacity of 30,000 tons per annum.

**PETROLEUM**

**World Production.** World's Production of Petroleum. Eng. & Min. Jl., vol. 111, no. 10, Mar. 5, 1921, pp. 433. Production in 1920 was 688,474,251 barrels against 554,505,048 barrels in 1919. In 1920 the United States supplied 443,402,000 barrels.

[See also OIL.]

**PHOTO-ELASTICITY**

**Uses in Machine Design.** Photo-Elasticity for Engineers—The Use of Photo-Elastic Methods in the Design of the Elements of Machines and Structures, E. G. Coker. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 222-226, 5 figs. Procedure suggested and illustrated by application to design of eye bars.

**PISTONS**

**Inspection.** Inspecting Pistons and connecting Rods, Fred H. Colvin. Am Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 407-410, 14 figs. Importance of inspection methods to quality of product. Methods in use on Essex and Studebaker pistons and connecting rods.

**Manufacture.** Manufacture of the Jahns Semi-Finished Pistons. Metal Trades, vol. 12, no. 3, Mar. 1921, pp. 95-97, 10 figs. Practice at Los Angeles plant.

**PLANING**

**Production Systems.** Production Planing in Machine Tool Plants, Edward K. Hammond. Machy. (N. Y.), vol. 27, nos. 6 and 7, Feb. and Mar. 1921, pp. 552-559, 8 figs., and 659-664, 8 figs. Methods used in shops of representative engine-lathe and planer builders.

Production Planing in Machine Tool Plants. Machy. (London), vol. 17, nos. 438 and 440, Feb. 17 and Mar. 3, 1921, pp. 597-604, 13 figs., and 680-684, 5 figs. Planer practice in a number of plants building milling machines and lathes.

**PLYWOOD**

**Tests.** Strength Tests of Screw Fastenings of Plywood, H. S. Grenoble. Aviation, vol. 10, no. 8, Feb. 21, 1921, p. 230. Tests conducted at Forest

TRADE MARK Rx REGISTERED

# RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

# CLINKERS

Clinkers are a nuisance—no one denies that—but some grades of coal will clinker.

The best way of handling them is the problem. Shall they be left undisturbed to grow into an immense fixed clinker or shall they be broken up as soon as they form and then gradually pushed down onto the dump and into the ash pit?

Years of study and experimentation in stoker design have evolved the Riley "moving grates" as the satisfactory solution to this problem.

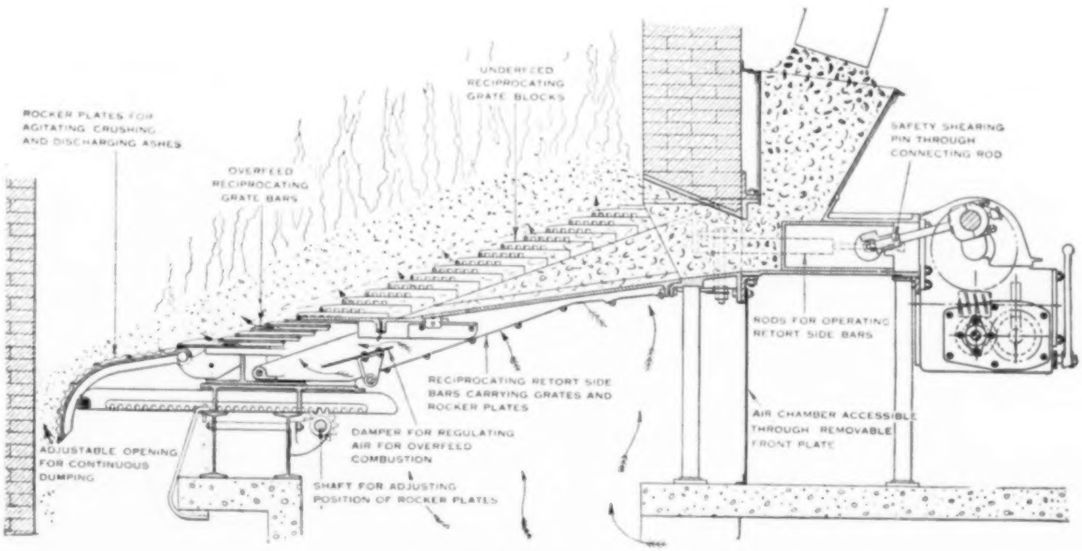
Before the clinker gets a chance to spread, the reciprocating retort sides start slicing and pushing the clinker down to the rocker dump where it is continuously crushed and discharged.

And thereby is avoided costly burn-outs from the reverbatory action of flames under large fixed clinkers when left undisturbed.

*Let the machine* do the work of breaking up and ejecting the clinkers instead of back-breaking labor on the part of the fireman.

There's more about the labor and fuel saving features of the Riley Underfeed Stoker in our Catalog A-5. Ask us to send you one.

*The Sanford-Riley Stoker Company is now prepared to equip new Riley Stokers with coal agitators licensed under the Negus-Tiffany patents.*




*"A type to meet every stoker need"*

**SANFORD RILEY STOKER CO.**
WORCESTER, MASS.
*Makers of*
RILEY UNDERFEED STOKERS
BOSTON NEW YORK
CINCINNATI

TRADE MARK Rx REGISTERED

PHILADELPHIA PITTSBURGH
CHICAGO ST. PAUL

**MURPHY IRON WORKS**
DETROIT, MICH.
*Makers of*
MURPHY AUTOMATIC FURNACES
BUFFALO CLEVELAND
DENVER

**ENGINEERING INDEX (Continued)**

Products Laboratory, U. S. Forest Service, Madison, Wis. Size and kind of screw, use of washers, margin, spacing and species of plywood and of member to which fastening was made, were included.

**PNEUMATIC TOOLS**

**Manufacture.** The Manufacture of Pneumatic Tools. Machy. (London), vol. 17, no. 439, Feb. 24, 1921, pp. 636–645, 22 figs. Review of methods employed by Consolidated Pneumatic Tool Co., Scotland.

**PORTS**

**New York.** Plans for Organizing the Port of New York. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 211 and 220, 1 fig. Automatic electric subway to eliminate surface congestion and reduce handling cost. Report presented to governors of New York and New Jersey by New York-New Jersey Port and Harbor Commission.

**POWER**

**Industrial Supply.** Industry's Supply of Energy, George Otis Smith. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 165–166 and 188. Survey of available supplies of coal, oil, and water, together with discussion of engineer's part in economic and efficient utilization of energy units.

**POWER PLANTS**

**Helgoland Island.** Power Stations with Diesel Engines on Helgoland Island (Kraftwerke mit Dieselmotoren auf der Insel Helgoland), H. Methling. Schiffbau, vol. 22, no. 16, Jan. 19, 1921, pp. 363–366, 6 figs. The two stations, supplying power, light and ventilation to all the plants and buildings of fortification works, are provided with five pumping works driven by Diesel engines of 345 hp. at 165 revolutions, besides which there are three Diesel dynamos, etc.

**POWER TRANSMISSION**

**Hydraulic.** Hydraulic Transmission of Power (La transmission hydraulique), A. Raudot. Revue générale de l'Electricité, vol. 9, nos. 6, 8 and 9, Feb. 5, 19 and 26, 1921, pp. 177–181, 18 figs., 239–243, 4 figs., and 279–284, 5 figs. System involving generator pump on rotary type with fixed cylinders arranged in star shape. Suggested design of 12-cyl. generating pump. Comparative study of characteristics of hydraulic and electric motion. Application of hydraulic transmission to railway traction.

**PRESSWORK**

**Pressed-Steel Parts.** Making Pressed Metal Parts Becomes Important Industry, E. L. Shaner. Iron Trade Rev., vol. 68, no. 9, Mar. 3, 1921, pp. 617–620, 6 figs. Development of manufacture of pressed steel in the United States.

**PROFIT SHARING**

**Legal Aspect.** Profit Sharing in Industry (La participation ouvrière aux bénéfices de la production), Paul Razous. Génie Civil, vol. 78, no. 4, Jan. 22, 1921, pp. 84–87. Arguments against legal compulsion of management to establish profit-sharing system. (Concluded.)

**Norway.** A Norwegian Plan for Profit Sharing. Monthly Labor Rev., vol. 12, no. 2, Feb. 1921, pp. 117–119. Plan worked out by Council of Nat. Workingmen's Assn., Norway.

**Plans for.** Encouraging Industrial Coöperation, A. H. Dittmer. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 549–551, 2 figs. Credit point system operated at plant of Dittmer Gear & Mfg. Corp., Lockport, N. Y.

**PROPELLERS, SHIP**

**Erosion.** The Erosion of Bronze Propellers, O. Silverrad. Jl. Soc. Chem. Industry, vol. 40, no. 4, Feb. 28, 1921, pp. 38T–45T, 8 figs. Also Shipbuilding & Shipping Rec., vol. 17, no. 7, Feb. 17, 1921, p. 183. Investigations into cause of deterioration. It is concluded that true cause of deterioration is mechanical, determining factors being frictional rub of water and impinging on propeller blades of water broken with evacuated spaces which subsequently collapse on propeller blades. Formation of erosion-resisting alloy.

**Manufacture.** The Manufacture of High-Class Marine Propellers. Eng. Production, vol. 2, no. 20, Feb. 17, 1921, pp. 227–236, 15 figs. Procedure at Charlton Works of J. B. Stone & Co., England. Paper read before Inst. of Mar. Engrs.

**PULLEYS**

**Standard.** Standard Belt Pulley, Chris Nyberg. Agricultural Eng., vol. 2, no. 1, Jan. 1921, p. 21, 1 fig. Chart for solution of pulley-spoke dimensions.

**Standardization of Diameters.** Standardization of Pulley Diameters (Normung der Riemenscheibendurchmesser), Ludwig Gück. Werkstattstechnik, vol. 15, no. 4, Feb. 15, 1921, pp. 87–90. Standardization of diameters based on standardized speeds which are presented in tabular form.

**PULVERIZED COAL**

**Uses.** A Series of Discourses on Use of Powdered Anthracite and Recovery and Use of River Coal, George H. Ashley, C. W. Webbert, Jonathan P. Edwards, G. R. Delamater, W. S. Guigley, Richard H. Vail, J. R. Wyllie, J. H. Kennedy, W. W. Pettibone and H. D. Savage. Jl. Engrs Club of Phila., vol. 38, no. 194, Feb. 1921, pp. 39–63, 8 figs. Statements by geological and mining authorities and engineers on best methods of pulverizing anthracite coal, together with results of boiler fires made at pulverized fuel plant at Lykens, Pa.

**PUMPS**

**Humphrey.** The Humphrey Pump. Engr., vol. 131, no. 340, Mar. 4, 1921, pp. 232 and 238, 4 figs. Installation of Humphrey pumps for Metropolitan Water Board at Chingford. Record of efficiency tests.

**Lubricator for.** A New Pump Lubricator. Engr., vol. 131, no. 3398, Feb. 11, 1921, p. 161, 2 figs. Prevention of airlock in oil passages when starting up is feature.

**PUMPS, CENTRIFUGAL**

**Gasoline-Engine Drive.** Gasoline-Engine Drive for Centrifugal Pumps, T. M. Heermans. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 376–377, 5 figs. Types of engines used. Curves show that engine horsepower should be 25 per cent greater than water horsepower required.

**PUNCHING MACHINES**

**Standardization.** Power Punches and Dies. Ry. Jl., vol. 27, no. 3, Mar. 1921, pp. 13–16, 2 figs. Discussion of standardization of punching machines at Am. Ry. Tool Foremen's convention.

# R

**RADIOMETALLOGRAPHY**

**Examining Materials.** X-Ray Examination of Materials, J. R. Clarke. Beama, vol. 8, no. 2, Feb. 1921, pp. 125–132. Experience obtained in research department of Metropolitan-Vickers Electrical Co., England.

**RAILS**

**Manufacture.** Steel Rails, C. W. Gennet, Jr. Jl. Western Soc. Engrs., vol. 26, no. 3, Mar. 1921, pp. 77–85. Comparative study of various processes for manufacturing steel rails.

**Sink-Head Ingots.** Steel Rails from Sink-Head and Ordinary Rail Ingots, Geo. K. Burgess. Dept. of Commerce, Technologic Papers of Bur. of Standards, no. 178, Dec. 15, 1920, 61 pp., 23 figs. Results obtained in experiments indicated decided superiority of sink-head ingots over ordinary ingots as made of three grades of steel.

**RAILWAY ELECTRIFICATION**

**Chicago.** The Illinois Central Electrification Project. Elec. Traction, vol. 17, no. 1, Jan. 1921, pp. 1–5, 4 figs. Ordinance regarding electrification of Chicago Terminals of Illinois Central Railroad was passed by Chicago city council July 21, 1919, and accepted by Illinois Central Railroad Co., Feb. 20, 1920. Details of project.

**Europe.** Electrification in Central Europe, E. C. Zehme. Elec. Ry. Jl., vol. 57, no. 10, Mar. 5, 1921, pp. 438–440. Résumé of conditions in Germany, Sweden, Norway, Holland and Italy.

Status of Foreign Electrification, E. C. Zehme. Elec. World, vol. 77, no. 10, Mar. 5, 1921, pp. 527–529. Developments in Germany, Austria, Sweden, Norway, Holland, Switzerland and Italy.

**Sweden.** The Electrification of the Swedish State Railways (L'électrification des chemins de fer de l'état suédois), M. Marchand. Industrie Electrique, vol. 30, no. 688, Feb. 25, 1921, pp. 68–72. Technical comparison of direct-current system with single-phase alternating-current system. Conditions in Sweden.

**RAILWAY OPERATION**

**Economics.** Report of Committee XXI—On Economics of Railway Operation. Bul. Am. Ry. Eng. Assn., vol. 22, no. 234, Feb. 1921, pp. 723–791, 13 figs. Methods for increasing efficiency of employees by furnishing them with reports and comparisons planned to inform and interest all concerned. Methods for increasing traffic capacity of railway, including analyses of costs and study of effect of speed of trains upon cost of operation.

**RAILWAY REPAIR SHOPS**

**Design.** A New Type of Erecting Aisle Saves Shop Headroom. Ry. Age, vol. 70, no. 9, Mar. 4, 1921, pp. 521–522, 3 figs. "Gap crane" erecting shop by which from 15 to 18 ft. of vertical height of shop building is saved.

**RAILWAY TIES**

**Life.** Tie Renewals in Relation to Average Life. Technical Note no. 130, Forest Products Laboratory, U. S. Forest Service, 2 pp., 1 fig. Comparisons of 43 groups included 42,000 ties of many species, some untreated and some treated.

**Pneumatic Tamping.** Determining the Cost of Pneumatic Tie Tamping. Ry. Maintenance Engr., vol. 17, no. 3, Mar. 1921, pp. 105–106. Records of tests conducted by Delaware, Lackawanna & Western Railroad.

**Standards.** Standard Specifications for Ties. Ry. Rev., vol. 68, no. 9, Feb. 26, 1921, pp. 327–328. Specifications adopted by Nat. Assn. of Railroad Tie Producers, Jan. 18, 1921.

**RESEARCH**

**Industrial.** Industrial Research. Iron Age, vol. 107, no. 10, Mar. 10, 1921, p. 638. Program being carried out by Engineering Foundation. Industrial research on nation-wide scale, in which engineering organizations, universities, factories, individuals and private laboratories and other organizations are coöperating is under way. From annual report of Engineering Foundation.

The origin and Development of the Research Associations Established by the Department for Scientific and Industrial Research, A. Abbott. Jl. Royal Soc. of Arts, vol. 69, no. 3561, Feb. 18, 1921, pp. 181–205. Department has so far approved and licensed 23 industrial associations.

**ROLLING MILLS**

**Universal Plate.** New Universal Plate Mill, J. H. Moore. Can. Machy., vol. 25, no. 9, Mar. 3, 1921, pp. 65–69, 7 figs. Installation of Dominion Foundries & Steel, Ltd., at Hamilton, Ont. Mill will roll universal plate from 7 in. to 41 in., shear plate to 64 in., and will also roll slabs and billets.

**Weirton, West Va.** Rolling Mills of the Weirton Steel Co. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 693–702, 9 figs. Compact arrangement of 40-in. blooming mill with two Morgan continuous mills, 21-in. and 18-in., for producing sheet bars, billets and slabs.

**ROOFS**

**Sawtooth.** A New Type of Saw-Tooth Construction. Manufacturers Rec., 79, no. 10, Mar. 10, 1921, pp. 95–96, 3 figs. Super-span construction devised by Ballinger Co., Phila.

# S

**SAFETY**

**Bureau of Mines Schedules.** Permissible Schedules Issued by the Bureau of Mines, L. C. Ilsley. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2211, 3 pp. List of active schedules available to manufacturers. Schedules establish minimum standards for safety and details of test methods in manufacture of explosives, electric motors, safety lamps, mine-rescue apparatus, storage-battery locomotives, etc.

**SAND BLAST**

**Apparatus and Uses.** Sand-Blast Apparatus (Sandstrahlgebläse), Wilhelm Kaempfer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 7, Feb. 12, 1921, pp. 175–178, 16 figs. Their use during war; sand blasts with rotary table and revolving drum; free-jet blasts; special constructions for cleaning of shells, removal of hammer scale from steel helm, etc., sheet-metal and structural-steel sections. Possible peace-time uses.

**SANDING MACHINES**

**Economical Speeds.** Determine Economical Sanding Speeds, James F. Adams. Abrasive Industry, vol. 2, no. 2, Feb. 1921, pp. 52–53, 2 figs. Curves constructed from results of sanding tests.

**SCHOOLS**

**Industrial.** A University in an Industry, Edwin Kurtz. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 191–193. Mutual university conducted by 6500 employees of Milwaukee Elec. Ry. & Light Co.

The Works School Exhibition of the German Committee for Technical Instruction in the Technical Academy, Berlin (Die Werkschulausstellung des Deutschen Ausschusses für Technisches Schulwesen in der Technischen Hochschule zu Berlin) H. Trost. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 21–26, 4 figs. Notes on exhibits from the apprentice schools of the Augsburg-Nürnberg Machine Factory (MAN); A. Borsig, Berlin-Tegel; German General Electric Co. (AEG); Bergmann Electrical Works; the Siemens concerns, etc.

**SCIENTIFIC MANAGEMENT**

See INDUSTRIAL MANAGEMENT.

**SCREW MACHINES**

**Automatic.** Magazine Feeds for Automatic Screw Machines. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 617–622, 10 figs. Equipments developed by Cleveland Automatic Machine Co., for handling second-operation work.

**Straight Forming Tools.** Dimension of Straight Forming Tools. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 560–564, 1 fig. Table giving depth of steps on straight forming tools measured at right angles to front face, corresponding to various differences between radii on work.

**SEMI-DIESEL ENGINES**

**Air Admission.** New Type of Mechanism for Air Admission in Semi-Diesel Motor (Nouveau type de commande d'admission d'air dans les moteurs semi-Diesel). Génie Civil, vol. 78 no. 7, Feb. 12, 1921, pp. 160, 1 fig. Rotary valve controls admission of air into cylinder in semi-Diesel engine manufactured by Ansald San Giorgio Corp.

**SEMI-STEEL**

**Cast Iron vs.** Cast-Iron vs. Semi-Steel, Ernest Wheeler. Foundry Trade Jl., vol. 23, no. 233, Feb. 3, 1921, pp. 99–100. Als. Eng. & Indus. Management, vol. 5, no. 8, Feb. 24, 1921, pp. 234–236. Tables are given showing results of tensile, physical, chemical and foundry tests of semi-steel and ordinary cylinder iron.

**Tests.** What is Semi-Steel? H. Field. Foundry Trade Jl., vol. 23, no. 237, Mar. 3, 1921, pp. 201–204. Records of chemical and physical tests. Paper read before Birmingham Branch, Instn. British Foundrymen.

**SHEARS**

**Large High-Speed.** Six-Foot High-Speed Shearing Machine. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 286–288, 7 figs. Driven by electric motor carried on bracket bolted to side frame, through cut gearing and treadle running whole length of front of machine.

**SHIP PROPULSION**

**Hydraulic.** The Hydraulic Propulsion of Ships


## Recording Industry's Progress

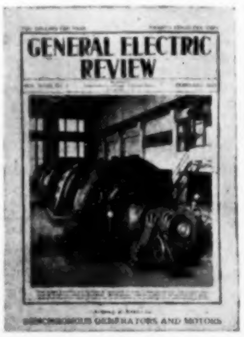
MOST of the new ideas, the changes in method, the contributions of all sorts to industry are conceived in the engineer's office and the research laboratory—at the centre of progressive activity. A magazine produced there is able to record the results of engineering investigation and scientific research well in advance of the spread of this knowledge. Such is the

## GENERAL ELECTRIC REVIEW
### A Magazine for Engineers

It speaks with the authority of men who have mastered industrial and engineering problems. Most of its messages are in their own words. Its pages express the trained knowledge and ripest thought of the General Electric Company engineers and scientists. To these it adds the authoritative contributions of many others who lead the march of scientific progress.

Because of this relationship The REVIEW is almost an autobiographic record of the work of many of the most prominent men in the electrical industry and much of the material it publishes is not obtainable elsewhere.

Three dollars sent to-day to Desk No. 387 General Electric Review, Schenectady, N. Y. will bring this magazine to you every month for one year.




# GENERAL ELECTRIC REVIEW

Schenectady New York

Scope of the
GENERAL ELECTRIC REVIEW

Science
Engineering
Wireless
Traction and Ry. Electrification
Hydroelectric Development
Power Conservation
Engineering Economics

**ENGINEERING INDEX (Continued)**

Engr., vol. 131, nos. 3398-3399, Feb. 11 and 18, 1921, pp. 140-142, 3 figs., and 172-194, 3 figs. Feb. 11: Hotchkiss hydraulic propulsion system applied to steel launch measuring 24 ft. in length overall and 6 ft. 3 in. in beam molded and having draught of 1 ft. 5 in. on displacement of 2 tons. Essential feature of system is creation of vortex that travels along with vessel. Feb. 18: Gill system, in which propulsive reaction of discharge stream is transmitted to hull through rollers mounted on vertical spindles.

**SHIPS**

**Gyrostabilizer.** The Effect of Bilge Keels and a Gyro-stabilizer, Wm. McEntee. Engineering, vol. 111, no. 2877, Feb. 18, 1921, pp. 208-210, 17 figs. Comparative tests of bilge keels and a gyrostabilizer on a model of the United States aircraft carrier Langley. Paper read before Soc. of Naval Architects and Mar. Engrs.

**Loading and Unloading.** The Loading and Unloading of Ocean Ships (Beitrag zum Lösch- und Ladeproblem der Seeschiffe), P. Appel. Schiffbau, vol. 22, no. 17, Jan. 26, 1921, pp. 387-389, 4 figs. Describes arrangement patented by R. Hundt in 1913 and developed by author with purpose of reducing to a minimum the path to be traversed by load and of reducing personnel required for loading and unloading.

The Mechanical Loading of Ships, H. J. Smith. Jl. Instn. Mech. Engrs., no. 1, Feb. 1921, pp. 67-96. Developments in mechanical systems of loading coal and ore into ships.

**SIGNALING**

**Selsyn System.** The Selsyn System of Position Indication, E. M. Hewlett. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 210-218, 16 figs. System consists of special transmitting generator electrically connected to similar receiving motor. Typical installations are described, notably those at locks at Panama Canal and similar equipment to be placed in operation at locks of New Orleans Industrial Canal. Further applications of system are visualized.

**SMOKE PREVENTION**

**Salt Lake Valley.** Swain's Report on Smoke in Salt Lake Valley. Chem. & Metallurgical Eng., vol. 24, no. 11, Mar. 16, 1921, pp. 463-465. Summary of field conditions surrounding Murray and Midvale smelters and resulting effect on plant and human life. Notes on operating conditions giving immunity from damage and difficulties in stipulating maintenance without hampering progress.

**SPRINGS**

**Helical.** Chart and Simplified Formulae for Helical Torsion Springs of Tempered Steel. Machy. (Lond.), vol. 17, no. 440, Mar. 3, 1921, p. 677, 1 fig. Dimensions and deflections for tempered steel torsion springs for maximum carrying capacity.

**STANDARDS**

**German N. D. I. Report.** Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 109-125, 18 figs. Approved standards for Whitworth and metric threads. Proposals of Board of Directors for round drawn copper, aluminum, brass and zinc wires and rods; precision round drawn steel and iron rods and wires. Proposed new standards for flat drive, sunk and gib-head keys.

**STEAM**

**Flow in Pipes.** Chart for Determining Flow of Steam in Pipes, Ernest Owen. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 269-270, 1 fig. Chart showing flow of steam in pipes.

**STEAM-ELECTRIC PLANTS**

**England.** West Bank Dock Electric Generating Station. Engr., vol. 131, no. 3398, Feb. 11, 1921, pp. 148-150 and 152, 9 figs. Steam-electric plant at bank of River Mersey, supplying power to alkali works in and around Widnes. Total capacity will be 20,000 kw. obtained from turbo sets of 5000 kw. each.

**Inspection.** Checking Efficiency of Generating Plants, John O. Fuchs. Elec. World, vol. 77, no. 10, Mar. 5, 1921, pp. 530-533, 6 figs. Inspection practice at plant of United Hudson Electric Corporation, Poughkeepsie, N. Y. Daily records which amount to 24-hour efficiency tests are kept for all units in the generating station.

**STEAM ENGINES**

**Michell Crankless.** The Michell Crankless Steam Engine. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 290-291, 5 figs. Engine works on uniflow principle. It comprises 8 cylinders, each 5 in. in diameter arranged four on each side of swash plate which is keyed to driving shaft of engine.

**STEAM POWER PLANTS**

**Ford Plant.** New Ford Plant Power House at River Rouge. Power, vol. 53, no. 9, Mar. 1, 1921, pp. 332-335, 3 figs. Consolidated blast furnace, steel mill, foundry and manufacturing plant. Double-ended boilers 83 ft. high, having 26,470 sq. ft. of steam-making surface, are arranged to burn blast-furnace gas and powdered coal.

**Location.** The Location of an Industrial Power Plant, M. K. Bryan and A. S. Wells. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 387-389, 4 figs. Importance of far-sighted planning for possible future developments is emphasized and typical examples of plants are quoted in which lack of space was cause of many troubles in operation and costly modifications in plant and equipment.

**Maintenance.** Maintenance-Department Methods I. Keeping the Power-Plant Records, Hubert E. Collins. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 418-421, 3 figs. Forms for keeping records.

**STEAM TURBINES**

**Governors.** The Governing of Steam Turbines, J. P. Chittenden. English Elec. Jl., vol. 1, no. 5, Jan. 1921, pp. 178-189, 15 figs. Principle of centrifugal governor, and its application to steam turbines.

**Pressure Distribution.** Pressure Distribution in Steam Turbines, Gerald Stoney. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 250-252, 1 fig. Formulas and graph.

**Reversing.** A Description of a New Reversing Turbine. Power House, vol. 14, no. 4, Feb. 20, 1921, pp. 37-38 and 40, 3 figs. Patented device.

**STEEL**

**Case-Hardening.** See CASE-HARDENING.

**Copper in.** Copper in Steel and the Corrosion of Cars, A. R. Surface. Sci. Am., vol. 124, no. 10, Mar. 5, 1921, p. 185, 1 fig. Service records of cars having both copper-bearing and plain steel plates. After six years of service copper steel plates showed practically no corrosion while plain steel plates were severely corroded.

**Defects in.** Defects in Steel and Their Detection, J. H. Andrew. Jl. West of Scotland Iron & Steel Inst., vol. 28, part 3, Dec.1920, pp. 28-31 and (discussion) pp. 31-35, 8 figs. on 4 supp. plates. Applications of micro-examination, macro printing, thermal curves, dilatation determinations, resistivity measurements and magnetic testing.

**Fatigue Tests.** Fatigue Breakdown in Automobile Steels, John Miller. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 321-325, 2 figs. Method of making fatigue tests.

**Magnetic Behavior.** The Magnetic Behavior of Iron in Alternating Fields of Frequencies Between 100,000 and 1,500,000 Cycles, Leon T. Wilson. Proc. Inst. Radio Engrs., vol. 9, no. 1, Feb. 1921, pp. 56-77, 11 figs. Mild-steel ribbon, 0.002 inch in thickness was tested at various radio frequencies between 100,000 and 1,500,000 cycles per second for relation between ampere turns per centimeter and flux density, and for core loss in watts per cubic centimeter at various frequencies.

**Molybdenum.** See MOLYBDENUM STEEL.

**Nickel.** See NICKEL STEEL.

**Rolling.** Application in Rolling of Effects of Carbon, Phosphorous, and Manganese on Mechanical Properties of Steel, Wm. R. Webster. Min. & Metallurgy, no. 171, Mar. 1921, pp. 49-50. Critical summary of results found by various investigators. (Abstract.)

**Specifications.** Exporting Iron and Steel—VII, V. G. Iden. Iron Trade Rev., vol. 68, no. 10, Mar. 10, 1921, pp. 698-703. Iron and steel specifications in foreign countries.

**Structural.** See STRUCTURAL STEEL.

**STEEL CASTINGS**

**Manufacture.** The Manufacture of Steel Castings, D. D. MacGuffie. Foundry Trade Jl., vol. 23, no. 237, Mar. 3, 1921, pp. 197-200, 6 figs. Process at Tropenas works, England. Paper read before Sheffield & Lond. Branches, Instn. British Foundrymen.

**STEEL, HEAT TREATMENT OF**

**Automobile Crankshafts.** Heat-Treatment of Low-Carbon Steel Automobile Crankshafts, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 521-523, 4 figs. Practice of H. H. Franklin Mfg. Co., Syracuse, N. Y., in heat treatment of crankshafts, including copper, plating, carburizing, and hardening operations.

**Quenching.** On the Distribution of Hardness in Quenched Carbon Steels, and Quenching Cracks, Kôtaô Honda and Sakaé Idei. Sci. Reports of Tohoku Imperial University, vol. 9, no. 6, Dec. 1920, pp. 491-507, 35 figs. Formation of quenching cracks is explained in light of theory of quenching developed by K. Honda in Sci. Reports of Tohoku Imperial University, 1919, page 181.

**Successive Treatments.** The Dimensional Limitation of Successive Heat-Treatments of Carbon Steel, W. P. Wood. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 345-346, 2 figs. Experimental records of change in length after rapid heat treatment. Hypo-eutectoid steel shrank more rapidly than others.

**Tempering of.** The Tempering of Steel (La tempra degli acciai), N. Parravano. Industria, vol. 35, no. 2, Jan. 31, 1921, pp. 26-33, 26 figs. Experimental study at Istituto Chimico della R. Universita, Rome, to determine nature of transformation which takes place during tempering of steel. Interpretation of photomicrographs.

**STEEL, HIGH-SPEED**

**Hardening.** A Note on Double Preheating High Speed Tools for Hardening, A. E. MacFarland. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 306-309. Practice of hardening high-speed steel tools using double preheating treatment. Advantages to be derived from double preheating operation.

**STEEL INDUSTRY**

**Germany.** Development of the Steel Industry During the War in Germany—III, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, pp. 202-205, 3 figs. Developments of electric drive for rolling mills.

**STEEL MANUFACTURE**

**Basic Slag.** Influence of the Basicity of Thomas Slag on the Operating Results of a Converter (Einfluss der Basizität der Thomasschlacke auf die Betriebsergebnisse des Konverters), L. Blum. Stahl u. Eisen, vol. 41, no. 3, Jan. 20, 1921, pp. 69-74. From analyses it is shown that the Thomas process operates most economically, both with regard to even dephosphorization and small consumption of manganese and to high degree of desulphurization and reduced waste, when the excess of lime calculated according to given formula amounts to about 4 per cent.

**Electric-Furnace.** Electric Furnaces for Making Steel—I, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, pp. 189-193, 7 figs. Classification of electric steel-making furnaces. General features and advantages of arc furnace and resistance furnace. Operating features of electric furnaces.

**STEEL WORKS**

**Basic Open-Hearth Melting Shop.** Basic Open-Hearth Melting Shop Equipment and Practice, G. A. V. Russell. Iron & Coal Trades Rev., vol. 111, no. 2764, Feb. 18, 1921, pp. 238-239, 2 figs. Basic open-hearth melting shop for output of 7000 tons of ingots per week. (Concluded.) Paper read before Swindon Eng. Soc.

**Eight-Hour Shift.** Eight-Hour Shift in British Steel Plants, Whiting Williams. Iron Age, vol. 107, no. 10, Mar. 10, 1921, pp. 635-638. Eight-hour shift has resulted in increased production and better feeling.

**Weirton, W. Va.** Enters Ranks of Steel Manufacturers, C. H. Hunt. Iron Trade Rev., vol. 68, no. 10, Mar. 10, 1921, pp. 685-691, 7 figs. Open-hearth and rolling mills of Weirton Steel Co., West Va.

New Steel Plant of the Weirton Steel Co. Iron Age, vol. 107, no. 10, Mar. 10, 1921, pp. 619-627, 9 figs. Plant includes blast furnace, open-hearth furnaces and mills for producing sheet bars, billets and slabs. Attention is called to labor-saving equipment installed. (To be concluded.)

The Plants of the Weirton Steel Company, C. H. Hunt. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, pp. 233-246, 12 figs. Description of steel plant, including blast furnace, open-hearth furnaces and mills for producing sheet bars, billets and slabs.

**STRESSES**

**Elongation and Shear.** Comparison of Theories of Elongation and of Shear Stress. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 193-194, 7 figs. Comparison of methods proposed for determination of stresses. Translated from Zeitschrift des Vereines deutscher Ingenieure.

**Structural Members.** Stresses in Structural Members and the Limitations of Material Testing (Spannungen in Konstruktionskörpern und Grenzen der Materialprüfung), O. Lasche. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 197-206, 30 figs. Discussion of examples of fabrication, bearing, load and peat stresses. Address presented before German Metallurgical Soc.

**STRUCTURAL STEEL**

**Standard Sections.** French Standard Sections. Bulletin technique du Bureau Veritas, vol. 3, no. 2, Feb. 1921, pp. 39-42, 14 figs. List of scantlings which have been adopted by French Standardization Committee appointed by French Government in June 1918. List includes all scantlings which are of general use and also those used in certain industries such as shipbuilding, mines, etc.

**SUPERPOWER SURVEY**

See CENTRAL STATIONS, Superpower.

# T

**TANK CARS**

**Reinforced-Concrete.** Reinforced Concrete Tank Cars (Wagons-réservoirs en ciment armé), Marcel Demouy. Outillage, vol. 195, no. 6, Feb. 10, 1921, pp. 177-178, 3 figs. Type developed at Delauney-Belleville car works.

**TERMINALS, LOCOMOTIVE**

**Design.** Report of Committee XXIII—On Shops and Locomotive Terminals. Bul. Am. Ry. Eng. Assn., vol. 22, no. 233, Jan. 1921, pp. 585-647, 75 figs. Typical layout for storage and distribution of fuel oil, including fuel oil stations between terminals. Design of enginehouses and power plants, store houses, car shops and coaling stations.

**Pere Marquette.** Small Engine Terminal Embodies Novel Details. Ry. Age, vol. 70, no. 10, Mar. 11, 1921, pp. 543-546, 7 figs. Locomotive and freight terminal on Pere Marquette at New Buffalo, Mich.

**TESTING MACHINES**

**Ball-Hardness.** A Small Ball-Hardness Testing-Machine, H. Moore. Jl. Instn. Mech. Engrs., no. 1, Feb. 1921, pp. 51-61, 7 figs. Machine developed for hardness testing of carriage cases. Load of 3000 kg. is applied through ball of 10 mm. diameter.

**Developments.** Recent Developments in Testing Machines, Thorsten Y. Olsen. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 131-134, 22 figs. Impact tension, impact shear, repeated impact, toughness and endurance, alternate torsion and transverse testing machines. Paper read before Am. Soc. for Steel Treating.

**ENGINEERING INDEX (Continued)**

**Torsion Strain Meter.** A New Torsion Strain Meter, E. H. Lamb. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 279–280, 7 figs. Each of ends of bars is attached to one of two brass tubes which slide freely one within the other. Slide twist of bar is measured by determination of relative motions of two plain mirrors, each fixed on one of brass tubes.

**THERMIT WELDING**

**Wrought-Iron Pipe.** An Unusual Case of Thermit Pipe Welding, Edward A. Miller. Power, vol. 53, no. 9, Mar. 1, 1921, pp. 351–352, 8 figs. Experience in welding wrought-iron pipe.

**TIDAL POWER**

**Severn Barrage Scheme.** Severn Barrage Scheme. Engr., vol. 131, nos. 3400–3401, Feb. 25 and Mar. 4, 1921, pp. 210–211 and 230–231. Account of joint meeting held by Instns. of Civil Engrs., Elec. Engrs. and Mech. Engrs. to discuss Severn barrage scheme for utilization of tidal power on Severn, and particularly third interim report of Water Power Resources Committee of making a plan for utilization of such power by means of a dam across estuary and a high-level reservoir a certain distance up the river.

**TIMEKEEPING**

**Time Clocks.** Time Measurement and Control (Zeitmessungen und Zeitkontrollen), Ed. Michel. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 59–62, 6 figs. Description of time clocks with special reference to the calculagraph clock. Report of the Assn. German Works Engrs.

**TIME STUDY**

**Group of Machines.** How to Make Group Time Studies, Philip Bernstein. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 187–189, 4 figs. Method of setting rates when a number of machines are operated by one man.

**TIRES, RUBBER**

**Substitutes.** Substitutes for Rubber Tires, H. Jahr. India Rubber World, vol. 63, no. 6, Mar. 1, 1921, pp. 417–421, 42 figs. In writer's belief, solids or semi-solids made of an infinite variety of compounds may be successfully used. Notes on fiber, cord, felt, hair, paper and cardboard, and asphalt tires. Translated from "Kunststoffe."

**TOLERANCES**

**Determining.** Tolerances in Mechanical Construction (Les "tolérances" dans la construction mécanique), C. Reinewald. Génie Civil, vol. 78, no. 6, Feb. 5, 1921, pp. 130–132, 7 figs. System of determining manufacturing tolerances.

**TRACTOR ENGINES**

**Drilling Operations.** Methods in a Tractor Engine Plant. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 516–518, 4 figs. Battery of drilling machines arranged for continuous operation.

**Manufacture.** Methods in a Tractor Engine Plant. Machy. (Lond.), vol. 17, no. 440, Mar. 3, 1921, pp. 665–668, 8 figs. Machining cylinder liners on rotary type of boring machine.

**TRACTORS**

**Columbus Show.** Parts and Accessories at the National Tractor Show, P. M. Heldt. Automotive Industries, vol. 44, no. 9, Mar. 3, 1921, pp. 497–500, 12 figs. Attention is called to air cleaners, traction devices for wheels tractors and automatic hitches, and also to rubber-tired wheels for road work, line-control mechanisms and drawbar pull indicator.

**Manufacture.** Machining Operations on Tractor Parts—I. Machy. (Lond.), vol. 17, no. 440, Mar. 3, 1921, pp. 661–664, 8 figs. Manufacturing practice of Wallace (Glasgow), Ltd., Cardonald, in building Glasgow tractor.

**Transport on Snow.** The Kégresse Motor for Transport on Snow. Engineering, vol. 111, no. 2878, Feb. 25, 1921, pp. 230 and 234–235, 12 figs. Accessories to motor-car chassis to enable it to be driven and steered over surface of snow and to climb gradients steeper than those met with on ordinary roads. Trials of machine have been completed by French Automobile Club at Mont Revard, France.

**TRANSPORTATION**

**Conditions in U. S.** Phases of the Transportation Problem, Francis W. Davis, Frank T. Hines, Gustav Lindenthal and J. R. Bibbins. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 181–183. Discussion on motor-truck transportation, government operation of inland waterways, and proposed plan for handling New York City's freight and passenger traffic. Abstracts of some of papers presented and discussion held at Transportation Session of annual meeting, Am. Soc. Mech. Engrs.

**TUBES**

**Seamless, Manufacture.** On the Manufacture of Seamless Tubes—I, Ing. Karl Gruber. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, p. 212. Mannesmann oblique rolling process.

# V

**VENTILATION**

**Ventilators.** Some Comparative Tests of Sixteen-Inch Roof Ventilators, H. L. Dryden, W. F. Stutz and R. H. Heald. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 93–100, 4 figs. Tests made at Bur. of Standards to determine comparative performance of rotary and stationary, and mushroom and siphon ventilators.

**VIBRATIONS**

**Machinery.** A Comparative Study of Vibration Absorbers, H. C. Howard. Jl. Indus. & Eng. Chem., vol. 13, no. 3, Mar. 1921, pp. 231–235, 6 figs. Apparatus for making comparative measurements of vibrations. Results of measurements of vibrations absorbed by various devices. Suggested arrangement of rubber balls for absorbing vibrations.

**VISCOSIMETERS.**

See OIL FUEL, Specifications.

**VOCATIONAL TRAINING**

**Disabled Men.** Training the Disabled. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, pp. 315–318, 6 figs. British Government instructional factory at Twickenham.

# W

**WAGES**

**Bonus Systems.** Bonuses for Quality as Well as Quantity, A. A. Blue. Iron Age, vol. 107, on. 11, Mar. 17, 1921, pp. 687–689, 2 figs. Employees on heat-treating department, Duff Mfg. Co., Pittsburgh, must keep temperatures within limits to get extra pay.

Premium Wage Plan in Milwaukee Shops, J. H. Lucas. Elec. Ry. Jl., vol. 57, no. 12, Mar. 19, 1921, pp. 528–532, 5 figs. Résumé of six years' experience with bonus pay for standardized jobs. System is now applied to 50 per cent of total time worked.

**Piece-Rate Method.** A Wage-Payment Method in Connection with the Taylor System. (Meine Lohnform im Taylorsystem), Justus Bormann. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 215–217, 1 fig. Author explains his system which is said to closely resemble Gantt's, differing therefrom in that an additional payment is made for time saved by workman. Comparison with other piece-rate methods.

**Systems.** The Wage Problem (Das Lohnproblem), E. Heidebroek. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 7, Feb. 12, 1921, pp. 165–169, 7 figs. Discussion of book by Schilling entitled Theory of Wage Methods. Graphic comparison of wage systems. Methods for exact time determination are said to form fundamental condition for every wage system. Notes on piece-rate system; importance of full utilization of production apparatus, etc.

**WASTE PREVENTION**

**Possibilities in.** Taking Up the Slack in Industry, Herbert Hoover. Eng. News-Rec., vol. 85, no. 8, Feb. 24, 1921, pp. 342–343. Possibilities in elimination of wastes and intelligent direction of productive power to reduce unemployment and labor friction.

**WATER GAS**

**Possibilities as Industrial Fuel.** Water-Gas, A. E. Blake. Proc. Engrs.' Soc. of Western Pa., vol. 36, no. 9, Dec. 1920, pp. 575–597 and (discussion) pp. 598–510, 10 figs. Possibilities of water gas as industrial fuel in U. S.

**WATER HAMMER**

**Conduits.** Water Hammer in Conduits (Les coups de bélier dans les conduits d'eau), M. Camichel. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs civils de France, vol. 73, nos. 7, 8 and 9, July–Sept. 1920, pp. 482–512, 24 figs. Calculation of stresses developed.

**Penstocks.** Calculation of Water Hammer in the Penstock of a High Reaction Turbine (Calcul du coup de bélier dans une conduite alimentant une turbine à forte réaction), M. de Sparre. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 8, Feb. 21, 1921, pp. 425–427. Formulas for computing stresses developed.

**WATER POWER**

**California.** Half Million Horsepower from Pit River. A. H. Markwart. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 581–584, 9 figs. Contemplated developments exceeding 450,000 kva. in northern California. First station now under construction. Line being built for 220,000 volts.

**Federal Power Commission.** Applications for Preliminary Power Permits Continue to Grow. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 585–587, 6 figs. Federal power commission reports receipt of 178 up to Feb. 26. Ten applications filed during month of February. Applications on file involve development of 13,725,166 hp.

**French vs. German Development.** Water Exploitation in France Since the War and the Development of German Water Powers (Die Wasserwirtschaft in Frankreich nach dem Kriege und der Ausbau der deutschen Wasserkräfte), H. Mattern. Elektrotechnische Zeit., vol. 41, no. 49, Dec. 9, 1920, pp. 980 and 983–985. Notes on utilization of water power in France before and during the war; electrification of the railroads; utilization of power and navigation of the Rhone River; the large waterway planned to connect the Rhine, Rhone and the Mediterranean; Saving in coal through the utilization of water powers; hydroelectric instruction in the technical schools and new French laws relating to hydraulics; France's competition with Germany, and conclusions for German water-exploitation policy.

**Switzerland.** The Wäggital Power Station Project, Switzerland (Das projektierte Kraftwerk Wäggital) Schweizerische Bauzeitung, vol. 77, no. 8, Feb. 19, 1921, pp. 85–88, 8 figs. Project to be begun in spring of 1921 is intended purely as a winter power-accumulating plant. Retaining dam is 900 m. above sea level, has a total encatchment area of 52.8 sq. km., and contains 140,000,000 cu. m. of water. Cost of project, 94,000,000 fr.

**Western U. S.** A Symposium Devoted to the Upbuilding of the West, John A. Britton, B. M. Rastall, E. S. Carman, M. M. O'Shaughnessy, C. F. Stern, E. O. Edgerton, Franklin T. Griffith and David P. Barrows. Jl. Electricity & Western Industry, vol. 46, no. 4, Feb. 15, 1921, pp. 189–202. Titles of addresses were: Water Power and the West; Industrial Research a Vital Factor in Substantial Growth; The West a Factor in World-Wide Industry; Civic Growth; Its Place in Industry; Finance and Industry; Helpful Utility Regulation an Aid in Industrial Growth; The Vision of the Industrial West; and The University Ideal and the West.

**WELDING**

**Steel Castings.** Fragility Incurred at "Blue Heat" in Welds of Steel Castings (De la fragilité au bleu dans certaines soudures d'acier), Charles Frémont, Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 7, Feb. 14, 1921, pp. 368–370, 3 figs. Experiments showed that weaknesses ordinarily developed in steel castings at critical temperatures between 200 and 450 deg. cent. could be overcome by eliminating during welding operation all oxidized metal from ends being welded.

[See also ELECTRIC WELDING; THERMIT WELDING.]

**WELDS**

**Testing.** Standardisation in the Testing of Welds, F. M. Farmer. Engr., vol. 131, no. 3400, Feb. 25, 1921, pp. 200–202, 4 figs. Three standards are suggested—shop standards, commercial standards and research standards. Paper read before Instn. Mech. Engrs.

The Desirability of Standardisation in the Testing of Welds, F. M. Farmer. Engineering, vol. 111, no. 2878, Feb. 25, 1921, pp. 239–242, 7 figs. Paper read before Instn. Mech. Engrs.

**WELFARE WORK**

**Bathhouses.** What H. C. Frick Coke Co.'s Experience Shows to be the Best Type of Bathhouse, D. J. Baker. Coal Age, vol. 19 no. 8, Feb. 24, 1921, pp. 349–354, 6 figs. Clothes are hoisted into bottomless lockerettes keeping clothes apart. Water kept thermostatically at 110 deg. fahr. Separation of rooms prevents splashing of water on men dressing. No locks used on clothes chains.

**Medical Attention.** Emergency Procedure in Shop Accidents. Metal Trades, vol. 12, no. 3, Mar. 1921, pp. 98–100. From miscellaneous bulletins of U. S. Public Health Service.

How to Treat Skin Affections of Employees, Walter C. Allen. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 180–181. Bulletin sent out by Ohio State Board of Health.

**WIND TUNNELS**

**Margoulis System.** Experimental Installations for Aerodynamic Researches (Sur les installations expérimentales de recherches aérodynamiques), Jean Villey. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 5, Jan. 31, 1921, pp. 270–272. Note on Margoulis system of testing aeroplane models in wind tunnels using carbonic-acid gas at high pressure and low temperature instead of air.

**Zeppelin.** Wind-Tunnel Installations (Die Windstromanlage des Luftschiffbau), Max Munk. Zeitfür Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 2 and 3, Jan. 31, and Feb. 15, 1921, pp. 20–22 and 35–38, 9 figs. Description of general arrangement and equipment of experimental tunnel erected by author at the Zeppelin works, said to be largest and most up-to-date installation of its kind. Discussion of general aspects for design of such installations.

**WIRE ROPE**

**Manufacture.** The Manufacture of Wire Rope, Carl King. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, pp. 196–197, 13 figs. General description of machines and operations involved in manufacture of wire rope at Palmer plant of Wickwire Spencer Steel Corp.

**WOOD PRESERVATION**

**Treatment.** Report of Committee XVII—Wood Preservation. Bul. Am. Ry. Eng. Assn., vol. 22, no. 233, Jan. 1921, pp. 442–479, 3 figs. Experimental investigation of comparative efficiencies of various treatments.

**WORKMEN'S COMPENSATION**

**Employers' Liabilities.** Liability for Lack of Ventilation, Chesla C. Sherlock. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 374–376. Scope of common and statutory laws. Liability under compensation acts. Effects of safety appliance laws, or factory acts.

**Social Insurance and.** Workmen's Compensation and Social Insurance, Carl Hookstadt. Monthly Labor Rev., vol. 12, no. 2, Feb. 1921, pp. 154–164. Cost of occupational diseases under workmen's compensation acts in U. S.

**WRENCHES**

**Manufacture.** Making 300,000 Wrenches Monthly, H. R. Simonds. Iron Trade Rev., vol. 68, no. 11, Mar. 17, 1921, pp. 756–759 and 761, 9 figs. Manufacturing methods at plant of Walden-Worcester, Mass.